D. Sylvester

Issued May 6, 1912.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF THE RED BLUFF AREA, CALIFORNIA.

By L. C. HOLMES and E. C. ECKMANN.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1910.]

WASHINGTON:
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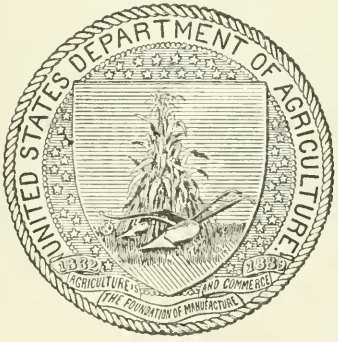

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., September 19, 1911.

Sir: In continuation of soil-survey work in the great interior valley of California a survey was made of the Red Bluff area during 1910. This area covers a part of Tehama and Butte Counties. This is a region of varied soils. Wide areas, underlain by hardpan, will never be of much value for agriculture. These areas will be used, as they are at present, for grazing. On the other hand, there are a number of fertile types at present used for dry farming and, to a relatively limited extent, for crops under irrigation. The development of the region agriculturally depends upon the installation of comprehensive irrigation works. Sufficient water to irrigate all of the better soils now passes down the streams during the flood period. It would be an engineering problem of great magnitude to store these flood waters in reservoirs along the upper courses of the rivers and to lead them thence by canals to the different parts of the area. The question of undertaking such a project, or projects, is under consideration, and preliminary surveys show it to be feasible. The outlining of the soils in the area and the valuation of the different types for the many special crops that may be grown in this region where sufficient water is obtainable should be of value as a basis for estimating the capital that may be safely invested in irrigation work.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1910, as authorized by law.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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Soil map, Red Bluff sheet, California.

SOIL SURVEY OF THE RED BLUFF AREA, CALIFORNIA.

By L. C. HOLMES and E. C. ECKMANN.

DESCRIPTION OF THE AREA.

The Red Bluff area covers the extreme northern portion of the main Sacramento Valley and its adjacent elevated plains. The northern boundary of the valley is formed by a series of low hills and wooded slopes which separate it from another valley on the north, known as the Anderson Valley.[1]

A small area of these low wooded hills is included within the survey. Here the river flows swiftly through a narrow winding gorge known as the Iron Canyon, and is bordered by a few small areas of alluvial soil in the bends. This condition continues to about 3 miles above the city of Red Bluff, where the hills on both sides of the river recede. At this point the great valley floor of the Sacramento begins. It extends southward as a valley 20 to 60 miles wide, unbroken save by the Marysville Buttes, to Sacramento and is continued thence to Bakersfield as the San Joaquin Valley.

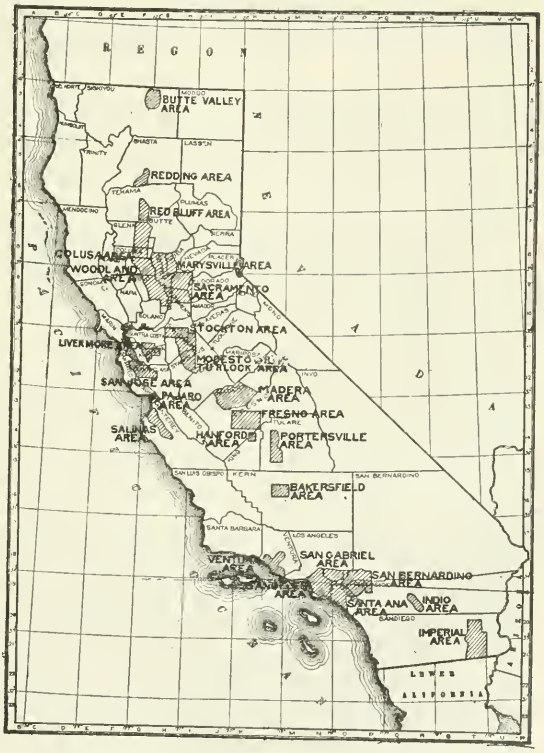

FIG. 1.—Sketch map showing location of the Red Bluff area, California.

[1] This valley is included in the soil survey of the Redding area.

The Red Bluff area covers a section of the valley from its northern end, near Red Bluff, southward to the Colusa area, a distance of about 27½ miles, a prolongation of the eastern and western boundaries of that area forming similar boundaries for the Red Bluff area. The area is covered by the Vina and Tehama quadrangles of the United States Geological Survey, these sheets being used as base maps. An exception is made of that part of the Vina Quadrangle previously covered in the Colusa area and such parts of the Tehama Quadrangle as have but comparatively little agricultural value.

The area consists of approximately 326 square miles, or 208,640 acres, all in Tehama County with the exception of some 10 square miles in the southeastern corner lying in Butte County. It would be rectangular in shape were it not that the lower Piedmont Plain of the Lassen Peak district, of no agricultural importance, borders the Sacramento River rather closely in the northeastern part of the area. The boundary of the survey is here so drawn as to include but little of this plain, the dissected front of which forms the boundary of the valley.

The Sacramento River enters the area near the northwest corner and pursues a general course to the southeast corner, dividing the area so that somewhat the greater part lies upon the west side of the river.

At the point where the river leaves Iron Canyon and enters the area an irregular flood plain, known as the "Sacramento Bottoms," begins. This varies in width from 1 mile to several miles. Through these bottoms the river meanders in an ever changing course. During excessive flood periods great areas of these bottom lands are submerged and active erosion follows through the overflow waters seeking lower levels by shorter channels than the tortuous river course. The main channel throughout the area occupies the lowest part of this alluvial bottom and in the main has sufficient carrying capacity promptly to relieve flooded sections. The condition does not exist in the Red Bluff area as farther south whereby a belt of elevated alluvial material has been built up along its banks, forming basins to restrain escaped flood waters after the river has fallen.

Few attempts are made to levee the river and keep it within its banks, and during flood seasons the water does considerable damage by restricting the area suitable for agriculture.

This flood plain throughout is marked by meandering overflow channels sometimes giving sections a much eroded surface. Such areas are abandoned to a tangled growth of wild grape, cottonwood, sycamore, willow, etc. The bottom lands were originally heavily wooded with the trees mentioned and when the agricultural development of the area started much labor and expense were necessary to clear it. It is now as extensively cleared as flood conditions warrant,

and produces a considerable proportion of the agricultural products of the area.

The low-lying alluvial belt of the Sacramento River is bordered along its outer edge by almost continuous terrace lines from 10 to 40 feet in height. These ascents mark the beginning of the plains region, which extends back on both sides from the river to the boundaries of the area. These gently sloping to rolling plains constitute the greater part of the area surveyed.

This plains region is usually treeless and of a naturally barren appearance, especially during the dry season. It has a good slope and is traversed by many small streams flowing at right angles to the river. Alluvial bottoms occur along many of these lateral tributaries. The principal streams of the west side are Reed, Redbank, Coyote, Oat, Elder, Thomas, and Rice Creeks, all finding an outlet to the Sacramento within the area. They are all intermittent streams, carrying periodically considerable volumes of flood water. Redbank, Thomas, and Elder Creeks are the principal ones of the group. The last two deliver large volumes of water during the rainy season, but soon dwindle once the season ends. From the eastern section several perennial streams reach the river, together with some intermittent streams of a character similar to those on the west side. Principal among the former streams are Antelope, Mill, and Deer Creeks, which deliver a continuous flow very valuable for irrigation purposes.

The population of the Red Bluff area is principally agricultural in character. There is a small percentage of the inhabitants dependent upon industries not intimately connected with agricultural pursuits, but in the main agriculture is their support. While a few foreigners and recent arrivals from near-by or Eastern States are found, the majority of the inhabitants are early pioneers and their descendants. They originally came from the Middle Western States and acquired large holdings of land. In many instances the large ranches are held much as they were when grain farming first began. Upon the plains region the population is usually very scattered. Along the alluvial plain of the Sacramento and its small tributaries the population is somewhat denser, but in general development of intensive agriculture is retarded by the large land holdings.

Tehama County, within which the survey lies almost entirely, has an area of about 3,200 square miles. It was established in 1856 from what was previously parts of Butte, Colusa, and Shasta Counties. In 1910 the population of Tehama County was 11,401; in 1900 it was 10,996. The increase in population has been due almost entirely to increase in settlement in the valley section covered by the survey.

Red Bluff is the county seat of Tehama County, with a population of 3,530. In 1900 it had 2,750. It is pleasantly situated upon the

west bank of the Sacramento River at an elevation of about 310 feet above sea level and is the most northern city in the main plain of the Sacramento River. The city was laid out in 1850 and first named Leodocia, quickly outstripping Tehama, an earlier settlement. During the mining excitement it was a great staging and transshipping point, being the head of navigation on the Sacramento River. It languished later during the decadence of mining, but revived with the advent of the California & Oregon Railroad in the early seventies. It is a very substantial city at this time and the distributing point for considerable outlying territory devoted to sheep and stock raising, lumbering, and mining.

Tehama, with a population of 221, is located on the west bank of the Sacramento River at the junction of the east and west side railroads.

Corning, the Maywood Colony town and the second in size in the area, has a population of 972. It is an agricultural town and the shipping point for considerable territory in Tehama County lying west of this area. Proberta and Kirkwood are other important local shipping points on the west side of the river.

Vina is a small town upon the east side of the river on the Shasta route of the Southern Pacific Railroad. It is noted principally as the headquarters of the famous Stanford ranch and is an important shipping point. Los Molinos, also upon the east side of the river, is a newly located town, the headquarters of operations tending to open for irrigation and settlement several thousand acres of land in that vicinity.

The area is well supplied with schools and excellent public buildings. Electric lighting and telephone communication in both towns and rural districts are in general use.

Good roads prevail and the main highways are excellently graded and well conditioned for traffic. Railroad transportation facilities are excellent. Two main lines of the Southern Pacific traverse the area, one on each side of the river. At Tehama the east-side branch crosses the river and joining the west-side branch continues as the main line of the Southern Pacific to Oregon. There are few points in the area removed as much as 6 miles from a shipping point on the railroad. In addition to railroad transportation the area possesses the advantages of river traffic. Owing to the obstructed conditions and to the occurrence of long periods of low water only a few boats reach Red Bluff each year. They influence railroad freight rates, and the possibility of improving the river's channel makes the stream a valuable natural asset.

An electric line has been proposed to traverse that section north of Los Molinos east of the river. This would materially improve its market facilities.

The markets for the products of the Red Bluff area are good. The northern California and southern Oregon country consumes much green fruit produced in this area. The dried fruits and staples, such as grains, hops, wine, wool, etc., are shipped to more distant markets. Vegetables, poultry, hay, and such products find markets in both northern and southern towns and supply much mountainous territory devoted to other industries.

CLIMATE.

The climate of the Red Bluff area differs little in general features from that characterizing the country known as the Great Interior Valley of California, of which it is a part. The most striking feature of the climate of this region, as compared with humid sections, is the occurrence of a wet and dry season. The summers are practically rainless, the entire precipitation occurring during the winter months.

The following table gives the mean monthly and annual precipitation for the stations indicated:

Mean monthly and annual precipitation.

	Red Bluff.	Corning.	Chico.	Orland.		Red Bluff.	Corning.	Chico.	Orland.
	Inches.	*Inches.*	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	4.82	4.51	4.46	3.26	August	T.	0.03	0.03	0.02
February	5.00	3.03	3.32	2.08	September	0.65	0.21	0.47	0.35
March	4.80	2.56	2.70	2.17	October	1.60	1.47	1.41	1.12
April	1.36	1.62	1.79	1.41	November	3.00	2.22	2.56	2.08
May	1.09	0.93	0.96	0.98	December	3.55	3.99	4.22	3.10
June	0.45	0.21	0.42	0.42					
July	0.01	T.	0.04	0.02	Annual	26.33	20.79	22.38	17.01

At Red Bluff, situated in the northern part of the area, on the west side of the river, the means are computed from records covering the period from 1877 to 1909. The elevation is about 310 feet above tide. Corning is located in the southwestern part of the area on the west side, and the figures cover the period from 1886 to 1900. Chico is situated about 5 miles east of the river and about 20 miles south of the Red Bluff area at an elevation of 193 feet. The period from 1871 to 1900 is covered by the figures. Orland is several miles south of the Red Bluff area on the west side of the river at an elevation of 254 feet. It will be noted that Red Bluff, at the head of the valley, has the greatest precipitation. For points oppositely located, however, it will be noted that the rainfall is somewhat greater upon the east side of the river. At all stations the greatest rainfall occurs in similar periods. The precipitation usually occurs as gentle

showers or rains extending over several days. A great variation is noted in the rainfall shown by calendar years. The records as kept for seasonal precipitations commencing with September do not show such a wide range, for the greatest rainfall of the season may occur either before or after the end of the calendar year. The following table shows the seasonal precipitation at Red Bluff from 1877–78 to 1909–10:

Seasonable precipitation at Red Bluff, commencing with September.

Year.	Total for season.	Year.	Total for season.	Year.	Total for season.	Year.	Total for season.
1877–78	53.14	1886–87	15.72	1895–96	23.94	1904–5	33.71
1878–79	21.49	1887–88	17.34	1896–97	24.90	1905–6	34.59
1879–80	29.94	1888–89	23.34	1897–98	15.18	1906–7	27.97
1880–81	28.90	1889–90	41.87	1898–99	21.70	1907–8	20.08
1881–82	21.12	1890–91	22.61	1899–1900	23.91	1908–9	31.23
1882–83	18.58	1891–92	21.39	1900–1901	24.59	1909–10	17.64
1883–84	24.01	1892–93	32.35	1901–2	31.74		
1884–85	14.74	1893–94	22.20	1902–3	24.22		
1885–86	35.11	1894–95	29.85	1903–4	31.64		

Maximum precipitations have occurred as follows: At Red Bluff, 49.01 and 40.37 inches for the calendar years of 1878 and 1906, respectively; at Corning, 34 inches in 1896; at Chico, 36.24 inches in 1892. Minimum precipitations occurred as follows: At Red Bluff, 12.91 inches in 1898; at Corning, 7.58 inches in 1898; at Chico, 12.31 inches also in 1898. The average annual rainfall for Sacramento covering a period of 51 years is 19.41 inches.

In the Red Bluff area the general movement of air is from the north and northeast into the valley. During the summer months there is normally a marked movement of air from the south. "Northers," as they are called, sometimes occur. They are hot, dust-laden north winds, occurring most frequently during May, June, and July. Some damage is frequently done to the fruits and growing crops during their passage, their hot, withering character extracting much water from the soil and vegetation.

Alternating periods of rainy weather and sunshine occur in the rainy season, but the summer months are very bright and clear, clouds being rarely seen. At Red Bluff from the year 1877 to 1909 the clear days average 216, partly cloudy 77, and cloudy 72 per year. The average number of foggy days at the same place for the same period was 9 per year. An average of 2 hail storms and 4 thunderstorms occur during each year. Snow in quantities is a rather rare occurrence, but in January, 1907, Red Bluff received 14 inches. Light frosts and films of ice appear during the winter months. At Red

Bluff the last killing frost occurs in spring at an average date of March 15; the first in the fall at an average date of November 25. The following table gives monthly and annual mean temperatures for several stations:

Monthly and annual mean temperatures.

	Red Bluff, 1878–1909.	Chico, 1870–1900.	Sacramento, 1853–1900.	Fresno, 1888–1900.
	° F.	° F.	° F.	° F
January	45.8	46.9	47.5	45.3
February	49.5	50.3	51.2	50.2
March	53.4	55.6	55.0	54.4
April	59.4	61.6	58.5	60.8
May	66.1	68.4	62.7	67.4
June	74.8	77.1	70.3	74.1
July	81.4	83.9	73.1	82.1
August	80.3	81.5	70.3	81.0
September	73.6	74.6	69.8	73.8
October	63.9	64.6	61.3	64.2
November	53.8	53.8	54.5	54.6
December	46.3	47.5	45.4	47.0
Mean	62.3	63.8	60.0	63.0

At Red Bluff during the period from 1877 to 1909 there was an average of 82 days per year when the thermometer did not fall below 90°. There was no day when it did not rise above 32° F. The absolute maximum temperatures usually occur during the months of July and August, high readings of 109° to 112° F. being of frequent occurrence. An absolute maximum of 115° was reached at the Red Bluff station during the summer of 1902. The highest temperature recorded at the Chico station has been 117° F. As is usual with the high temperatures of semiarid regions, the oppressiveness is diminished by the extreme dryness of the air. The nights are not usually oppressive. The absolute minimum temperatures are usually recorded during the months of December, January, and February. Low temperatures of 24° to 28° F. are the rule. In 1885 the low temperature at Red Bluff was 33°. An absolute minimum of 18° was reached in January, 1888. The lowest temperature recorded at the Chico station is also 18° F.

The climate of the Red Bluff area is remarkably salubrious. As with the major part of the great valley, it is very well suited to fruit culture, the absence of rains during the summer allowing the curing of dried fruits and hay to proceed without loss. Frosts do little damage to fruits. The uncultivated sections have a rather bleak appearance during the hot summer months, but the winter months present a marked contrast. At those times when the eastern humid sections are barren of green growth the winter rains of this

section revive all small vegetation, and a fresh, green appearance is everywhere noted. During the springtime the area is at its best.

AGRICULTURE.

The history of the early settlement of the area is indefinite and uncertain. It is certain, however, that Gen. John Bidwell, of Sutters Fort, on the site of Sacramento City, visited Tehama County in 1843, named most of the geographical points, and secured valuable information concerning the section. The following year William G. Chard, A. G. Toomes, and R. H. Thomas became the first settlers. Upon entering the region the early settlers allotted the land among themselves, with the ultimate aim of securing large grants from the Mexican Government. They made their first camp on Elder Creek, and mention is made of the presence of deer, elk, and other game animals, previously undisturbed, in large numbers. A heavier growth of wild oats and native grasses everywhere appeared than was the rule in later years. The Mexican land grants made within the present limits of Tehama County were as follows. They were finally confirmed by the United States Government on the dates indicated:

Name of grant.	Area.	Grantee.	Year confirmed.
	Acres.		
Las Baulinas	17,707	W. B. Ide	1860
Las Flores	13,315	W. G. Chard	1859
Primer Canyon Rio de los Berrondes	26,637	J. F. Dye	1871
Rio de los Molinos	22,172	A. G. Toomes	1858
Saucos	22,212	R. H. Thomas	1857

Gen. Bidwell took the famous Chico ranch, while Maj. P. B. Reading took a grant north of Cottonwood Creek in Shasta County, covered by the Redding area survey. The two latter men are closely associated with the incidents surrounding the early settlement and development of this region.

These early pioneers worked on their places, endeavoring to develop a cattle industry, until the discovery of gold in 1848. They then left their farms for the mines, but afterwards returned when their experience had been sufficient. The impression existed generally that the soil of the entire area was not suitable for farm crops and that stock raising was the only practicable industry. Along such lines the development extended.

Farming began in 1852 with an experimental crop of grains, and from that date the movement spread rapidly. The first sawmill and gristmill were erected in 1851 on Mill Creek at the river. It is

interesting to note that the first steamer on the upper Sacramento was the *Lady Washington*, in 1849–50, and that several small steamers navigated the canyon above Red Bluff in these early days. An influx of population, due in part to a movement of mine seekers, led to the development of various industries, with which agriculture kept pace. Wheat growing received most attention. It was at first confined to the deep alluvial soils along the streams, but gradually extended over the uplands until all tillable land of the area was sown to grain under extensive systems. Profits were good and enormous quantities of grain were shipped into the world markets by railroad and river steamers. The usual methods applicable to an extensive system of agriculture, embracing the use of the gang plow and the combined harvester, were employed. Even with such labor-saving machinery, enabling large tracts to be farmed, the industry declined in the face of decreased yields and lower prices. A gradual shrinkage in the area devoted to grain has followed, until at this time the grain belt is practically confined to the bottom lands. The upland types, as noted in their descriptions, are now devoted mainly to grazing. Such parts of the latter sections as produce grain do so only by practicing summer fallowing. The principal part of this abandoned upland section is very sparsely settled, and while land values are lower than in the best grain-producing days they are not yet at a low ebb because of irrigation possibilities. About 1,500,000 bushels of grain are annually produced.

There are many small holdings of land in the Red Bluff area, but some of the great land grants and subsequently acquired tracts remain nearly intact, extending over hundreds and in some cases thousands of acres. They retard the development of the section, but subdivision is hardly possible without irrigation. A large body of land near Corning has been gradually sold in small tracts since the early nineties. A tract around Los Molinos has recently been watered and is now being disposed of in small farms. Some of the alluvial bottoms of the Sacramento and the soils along Thomas and Elder Creeks are held in moderate-sized tracts, but great holdings cover the most of the area. Among these may be mentioned the great Finnell and Cone ranches near Red Bluff, the Stanford ranch near Vina, and others.

At about the time when grain growing began to decline in this area, fruit growing was tried with increasing success. (See Pl. I, fig. 1.) The more friable alluvial soils of good water-holding qualities were selected, and by careful methods quite a fruit industry has been built up on a dry-farming basis. Irrigation is practiced in certain sections, as noted further on in this report under the proper head, but the greater part of the fruit is produced without it. In 1907 Tehama County produced $1,281,531 worth of deciduous fruits, with

peaches, prunes, and apricots of importance in the order named. The peaches are used mainly for canning and drying, Muir, Crawford, and Elberta being the varieties mostly used. Apricots are both dried and shipped as green fruit. Figs, almonds, olives, pears, and grapes are well represented. (See Pl. I, fig. 2.) The 100-acre irrigated pear orchard of the Cone ranch is reported to have netted its owners $32,000 in one year. There are many good orchards of the above fruits in the Red Bluff area, but also great numbers of poorly cared for or entirely abandoned orchards. This condition arises from various causes, but is often due to the selection of dry elevated soils, where it is too much to expect fruit trees to thrive without irrigation. Some injudicious colonization has taken place. Considerable sections have been planted and sold in small holdings with the idea of special crops without irrigation. Scarcely a vestige remains of some such attempts. The probable adaptations of the several soils for dry-farmed crops are covered in the soil-type descriptions.

Green feed is abundant during the winter season, but the dairying industry suffers for want of such feed in the summer months. Under irrigation the industry should expand immensely.

Tehama County is one of the banner sheep counties of the State, with about 300,000 head. Cattle number about 30,000. Stock range in the mountains from May to October and in the valley during the winter, when they are fattened. The cattle and sheep industries are not likely to assume much larger proportions than they have at present.

Alfalfa is the principal hay crop and is grown mainly in the Sacramento bottoms without irrigation. A mill for the manufacture of alfalfa products has been established at Alfalfa, south of Red Bluff.

The Stanford ranch at Vina has about 3,000 acres in grapes of the wine varieties. The dairying, wine, and alfalfa industries at that place are well handled and are a remarkable example of farming on a large scale.

Most of the vegetables and truck crops are grown by Chinese. As usual in this section of the country the farmers buy such products.

Several cars of citrus fruits are reported shipped from Corning each year (see Pl. II, fig. 1). The future extension of this industry is uncertain.

Two or three hop fields are found in the Sacramento bottoms. Poultry raising is quite an industry, especially to the west of Corning. Climatic conditions are very favorable and great increases in this branch are probable.

The Red Bluff area produces many agricultural products, but agriculture is in a very unsatisfactory state. The natural wealth of the section in undeveloped resources is immense. Its diversity of soils and favorable climatic conditions will some day make it a

vast producer of widely varied crops and render it a section of small intensive farming industries. It has not as yet, shared in that extensive irrigation development which has transformed so many of the other regions of the State into gardens of productiveness. All agricultural interests are feverishly awaiting irrigation development, and perhaps a foresight of the greater era to come discourages any attempt to make the most of present conditions. A realization of the next necessary step is everywhere present, and land values as well as attitudes toward agricultural development all anticipate the coming of extensive irrigation. Prices of land over the entire area are based upon their worth as irrigable lands and not upon their intrinsic present worth without water. The improvements anticipated are certain to come and everyone realizes the present transitory state of agriculture.

IRRIGATION AND DRAINAGE.

The Sacramento Valley is perhaps the only region of its size and importance in the United States whose advancement and development is retarded by such conflicting soil conditions. Great bodies of rich, deep soils are rendered uninhabitable or practically useless for agricultural purposes by periodic floods. Bordering the territory so affected are other still greater bodies of soil only slightly more elevated yet continuously lacking even the relatively small supply of moisture needed to mature even a grain crop.

It is principally upon soils occupying the mean between these two extreme conditions that the greatest number of homes and industries have been built. The greater areas occurring as overflow and semiarid lands have nowhere been extensively utilized or effectively managed. The largest problem of the future in the Sacramento Valley will be the reclamation, through a comprehensive drainage and protection project, of the lands now rendered useless by floods, and the storage of waters for the irrigation of such lands as need irrigation. The engineering and financial features involved are formidable and intricate, but must be solved in the progress of time. It is agreed that the ideal method involves the simultaneous handling of the two problems. Storage of vast quantities of water will relieve the flooded areas, and the stored water will be available for irrigating the higher lands. Pending the consummation of such a vast undertaking various irrigation systems of small scope have been installed throughout the valley. The Red Bluff area contains some such scattered systems.

The lower soils of the Red Bluff area are not subject to such extensive and continuous flooding as in sections of the valley occurring farther south. Much damage is done, however, and the handling of the flood waters of the Sacramento would materially increase the pro-

ductiveness of the river bottoms. The installation of irrigation with pumping plants or other systems would then be possible without danger of loss during floods. Leveling and other improvements could proceed in an uninterrupted way. There are many parts of this low-lying belt farmed from home buildings located on the uplands. Under such conditions it can easily be seen that intensively farmed small tracts are impossible without river control. Fortunately the river bottom soils are the only ones of the area with adverse drainage conditions. No doubt the greater part of the Sacramento bottoms could be irrigated by pumping at this time were it not for the floods at points where the necessary plants must be placed. The manner and extent of the damage by flooding is discussed in the description of the soil types.

The several small irrigation systems established in the Red Bluff area lie largely upon the east side of the river. The three most important perennial streams of that section furnish water to more or less extensively irrigated tracts. Water from Antelope Creek has been used in the general farming operations of the Cone ranch for many years. Considerable areas of alfalfa and some good orchards on the ranch are irrigated from this source. Chinese vegetable gardeners are also supplied. The soils covered by these systems are principally those of the Vina series. Extension of the irrigated area is possible, but it is not probable that Antelope Creek carries sufficient water for all the soils lying within its delta capable of irrigation.

The Los Molinos tract, consisting of about 10,000 acres along and bordering the delta of Mill Creek, has been subdivided and placed upon the market with a water right in that stream. Considerable irrigation development has taken place upon the various types of the Vina series and will no doubt be extended. Quite a body of small farms intensively cultivated can be built up in this region lying between the Tuscan series and the Sacramento River. The supply of water will be exhausted, however, before all the land is developed.

The Vina section is quite liberally irrigated by water from Deer Creek. As in the vicinity of the other creeks of the east side, there are bodies of good soils favorably situated for irrigation, yet unirrigated because of inadequate water supply. The combined flow of the three perennial east side streams is not sufficient to serve all of the irrigable soils of that section. More conservative use can be made of the water and good intensively farmed sections developed, but there will still remain large areas to be watered from other sources.

A portion of a tract of land known as the Richfield Colony, lying west of Corning, irrigated during the spring by water from intermittent streams of the locality, is also covered by the survey. Natural subirrigation giving rise to moist subsoils here assists in bringing about conditions favorable to crop production. At intervals along

FIG. 1.—PEACH ORCHARD ON CONE RANCH NEAR RED BLUFF.

[An example of successful fruit culture in the Red Bluff area.]

FIG. 2.—ALMOND ORCHARD NEAR CORNING, ON A FAVORABLY SITUATED AREA OF TEHAMA SILT LOAM.

[An example of a well-kept and thrifty orchard.]

FIG. 1.—A SUCCESSFUL SMALL ORANGE ORCHARD NEAR CORNING, TEHAMA COUNTY.

[Irrigated from small pumping plant.]

FIG. 2.—ROUGH STONY LAND OF VOLCANIC BOWLDERS OCCURRING EAST OF VINA.

the Sacramento River and Thomas and Elder Creeks, and in the vicinity of Corning, small amounts of water are supplied for irrigation by several pumping plants. The soil types irrigated by means of pumping are designated in their individual descriptions. Electric power for pumping is available at low rates and the feasibility of the system depends simply upon a question of the water supply.

The total development in irrigation above noted is considerable, but in no way approximates the possibilities of the area. The Iron Canyon project has been much talked of. This is an enormous undertaking, involving features of storage, river control, and irrigation. All the drainage water of the upper Sacramento Basin flows through the Iron Canyon, previously mentioned as being located a short distance above Red Bluff. It is described as a natural reservoir site, and in conjunction with others of a similar nature farther north and south can be used to store sufficient water for the irrigation of 2,000,000 acres. The reclamation of vast areas of overflow land would follow the storage of flood waters. The immense benefit which would result to all the valley is unquestioned. Its magnitude rather than questions of feasibility is all that delays the undertaking.

It is reported that Elder and Thomas Creeks have storage possibilities at various points along their upper courses. Their annual flood discharge is enormous, and the development of lands with water drawn from such reservoirs is perfectly feasible.

It is believed that a study of the soil type descriptions will reveal their adaptations and possibilities under irrigation. The question of success or failure of a project of course depends primarily upon the character of the soils.

The entire future of the Red Bluff area will be identified with irrigation. Practically all development must come through its further extension.

SOILS.

The soils of the Red Bluff area were separated into 26 types. Two additional types of no agricultural value were also outlined, namely, Riverwash and Rough stony land. Certain of the former types are related to each other in origin, in process of formation, and topography, and are arranged in groups on a basis of these many resemblances. The boundaries between the types of the same series, as well as between types of different series, are not at all times distinct, but similarities and differences are sufficiently marked to throw the 26 types into nine broad divisions, each containing several types.

Excepting the Rough stony land, the soils of the area are derived in part from the original deposits of the Sacramento Valley, and in part from ancient and modern alluvium of the streams that traverse the region. The former consists broadly of two types of deposits.

West of the Sacramento River and in a very few places on the east side, it consists of sand, clay, and waterworn gravel. The pebbles in the gravel are usually small, well rounded, and derived from fine-grained eruptive rocks, quartz and quartzite, etc. The pebbles when exposed are usually weathered to a reddish color, or are mixed with and coated with the finer material, which is reddish in color. In general, on the east side of the valley the ancient deposit consists mainly of waterworn gravel with a relatively small proportion of sand and a still smaller proportion of clay. The pebbles are much larger, as a rule, than those on the west side, are well rounded, and derived from basaltic rocks. The sands are likewise mainly basaltic in origin, with small quantities of quartz, and in addition, there are occasional layers of basaltic tuff.

The soils derived from the ancient deposits of the western side of the valley are classed under the head of the Redding, Corning, and in part, as the Tehama series.

In the Redding series two types were mapped. They are prevailingly reddish in color and usually carry quantities of waterworn gravel. These types occupy the highest elevations in their section of the survey and are gently sloping to rolling in contour. They possess thin layers of heavy subsoil resting directly upon a true, impenetrable hardpan several inches thick. This hardpan in turn is underlain by indefinite masses of coarse deposits in a partially cemented condition. Most of this series is poorly adapted to dry-farming methods, is barren in appearance, and locally known as "red lands" or "hardpan lands."

In the southwestern part of the Red Bluff area occur several bodies at about the same relative elevation as the Redding series farther north in the area. These ridges and small elevations in this section are occupied by remnants of the Red Bluff formation, but in an altered state sufficient to remove them from the Redding series. The true hardpan seems to have been removed, and there are somewhat deeper coverings of soil resting upon the semicemented deeper layers. This material constitutes the Corning series with two type subdivisions. As with the Redding, it is a distinctly west-side series, and poorly adapted to dry farming.

The Tehama series occupies two topographic situations and is derived from two different materials, so far as origin is concerned. All of the Tehama soils in the northwestern part of the area are terrace soils, occupying smooth areas lying a few feet below the level of the Redding soils and several feet above the modern alluvial plains. In most cases these are the terraces of the small streams draining the western side of the valley, which carry local material mainly, only their headwaters reaching back into the foothills of the coast ranges. One of the largest areas is on a well-developed

terrace lying south of the modern channel of Redbank Creek. Narrower belts occur along all the other eastward-flowing streams.

Northwest of Corning there is a considerable area of Tehama soils derived directly from the weathering of the Red Bluff formation. This area occurs in gently rolling country and merely represents an area of Red Bluff material that has been eroded down to a very gently undulating plain. It is residual in origin, while the other areas are alluvial in origin.

The Tehama types are prevailingly yellowish or yellowish brown in color, deeper than the soils of the previously mentioned series and fairly friable. A heavy subsoil usually occurs. They are well adapted to irrigation, but yield scant crops under dry farming. The distribution of this series is very general over the west side.

The Maywood series comprises five types of soil formed on the terraces and alluvial fans of the small streams in the southwestern part of the area. They occur on the level areas bordering these streams, and lie below the level of the series already named. The areas are usually broader to the west and narrow to the east on account of the broadening of the alluvial fans upstream. The series as a whole is grayish or yellowish gray in color and more friable than the Tehama series. This series is better adapted to dry-farmed fruit and grain than any of the series before mentioned, but yields are light and could be greatly increased under irrigation. The Maywood series occurs at intervals over the west side, being confined to that section.

In the southern part of the area occur inextensive bodies of soil material derived by washing or erosion of adjacent more elevated bodies of soils, viz, the Corning series. It is deposited over lower valley plains, local flats, or depressions. It represents eroded material modified by local conditions of restricted drainage, of dark-gray color, and compact, refractory structure. In this area the material gives a single soil type. It is classed as a member of the Kirkwood series.

Several of the west side major streams have constructed alluvial bottoms from foreign material along their courses in the Red Bluff area. These soils are mostly derived from rocks along the sources of Thomas and Elder Creeks in the foothills and mountains of the Coast Range, and have not been greatly influenced by addition of material eroded from adjacent soils. These depressed valley soils enter the west edge of the survey and continue to the great alluvial plain of the Sacramento, where they gradually lose their identity. They are dark in color, deep and friable in character, and excellent soils for every purpose. Three types were found and classed as the Elder series.

The soils derived from the original valley deposits, occurring on the eastern side of the valley, come from what is locally known as "lava flows." The soils are reddish brown or brown shallow soils of little or no agricultural value. They occupy a sloping dissected plain and are burdened with great quantities of bowlders of varying size derived from volcanic rocks. An impenetrable mass of cemented waterworn gravel is encountered at a depth of a few inches and extends to great depths. These are probably the most hopeless soils of the area and are classified as the Tuscan series, represented by two types. They are derived from valley deposits probably of the same age as the Red Bluff deposits, but derived from the volcanic rocks of the Lassen Peak region. The great body of the deposit is a coarse mass of rather well-worn pebbles and bowlders of volcanic rocks with interstratified beds of finer material, the latter including some beds of tuff. The series is separated on its lowest edge from the Sacramento bottoms by sharp bluffs 20 to 60 feet high. It is extremely arid, unproductive, and capable of little development. Ages ago it occupied a much greater extent than at present, but processes of erosion have removed the material over wide areas and other areas have been covered with alluvium.

The Vina series, consisting of four types, is confined to the east side of the valley. These soils are alluvial in character and the product of the numerous east side streams. They occupy sections occurring as valleys or deltas once occupied by the Tuscan series. The series is usually separated from the Tuscan series by marked terraces, but at its lower edges it merges gradually into the slightly lower Sacramento series. These soils are in the main brownish or dark gray in color, friable, and productive. Some of the members constitute the best soils of the area, while one or two are unproductive.

The soils of the great alluvial flood plain of the Sacramento, which traverses the area, were classed here, as in the other areas surveyed in the valley, as the Sacramento series. Four types were recognized and correlated with previously recognized types. These soils are the direct product of sedimentation by the Sacramento River, the materials being derived along its upper course. They are light gray or dark gray in color, slightly micaceous, and of variable textures and indistinctly separated from each other. A deep soil and friable structure are the rule. The series comprises the most productive soils in the area. It occurs as a broad, level plain marked by overflow channels with considerable sections subjected to flooding. A marked terrace bounds its outer limits and the river occupies a winding channel 10 to 20 feet deep through its level surface.

The great variability in the soils of the Red Bluff area makes few general statements possible. They are usually well drained and productive whenever moisture conditions are favorable. It is no doubt

the best drained section of the valley. The upland soils are always deficient in organic matter, but can be improved under irrigation and by the addition of green manures. Alkali is nowhere present. Even ordinary care in the use of irrigation water will relieve this area of all the danger from alkali so frequently resulting in other irrigated sections.

The following table gives the names and extent of the various soil types found in the Red Bluff area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Tehama silt loam	29,888	14.3	Tehama gravelly loam	4,032	1.9
Tuscan stony sandy loam	25,728	12.4	Sacramento silty clay loam	3,584	1.7
Sacramento silt loam	19,328	9.3	Elder silt loam	3,392	1.6
Corning gravelly loam	18,752	9.0	Riverwash	3,200	1.5
Corning loam	9,280	5.8	Maywood silt loam	2,368	1.2
Sandy phase	2,880		Maywood gravelly sandy loam	2,048	1.0
Redding loam	11,456	5.5	Elder silty clay loam	1,600	.8
Sacramento fine sandy loam	10,496	5.1	Tehama clay	1,536	.7
Vina fine sandy loam	8,768	4.2	Maywood fine sandy loam	1,536	.7
Maywood loam	8,576	4.1	Kirkwood silty clay adobe	1,536	.7
Tuscan stony loam	8,000	3.8	Sacramento fine sand	896	.4
Vina clay loam	6,848	3.3	Elder gravelly fine sandy loam	832	.4
Rough stony land	5,824	2.8	Maywood silty clay loam	384	.2
Redding gravelly sandy loam	5,504	2.6			
Vina loam	2,368	2.6			
Deep silty phase	3,072				
Vina clay adobe	4,352	2.4	Total	208,640	
Deep phase	576				

REDDING LOAM.

The Redding loam in some of its general features resembles the gravelly sandy loam of the same series, but in agricultural value there is a marked difference. This type is remarkably uniform and consists of a loam, yellowish red to red in color, sticky and boggy when wet, and carrying considerable quantities of medium-sized waterworn material. The coarser particles range in size from sand and subangular fragments to rounded gravels 2 inches or more in diameter, quartz often predominating. Such quantities of coarse material, which would usually render a soil rather friable, fails in this case materially to improve the tilth. This is due to seasonal conditions, saturation being quickly followed by a compact puddled state, rendered somewhat worse by a low content of organic matter. This surface loam at 6 to 18 inches grades sharply into a subsoil closely resembling that of the Redding gravelly sandy loam, being a red clay or clay loam of impervious, slightly indurated structure. The subsoil carries some embedded gravel and cracks freely on exposure. It is in this case, however, of a darker red color and much

more shallow. Rarely is it ever over 6 inches thick and in all but very limited bodies underlain by a hardpan. This is somewhat thicker and harder than that underlying a portion of the Redding gravelly sandy loam. The line of contact between the layer of heavy subsoil and the great bodies of underlying impervious beds is quite clear, but that portion defined as a true hardpan occurs as the harder portion directly in contact with the subsoil. It is composed largely of clay particles firmly cemented into an impenetrable layer carrying little gravel. This true hardpan is a secondary development, occurring after the entire mass was deposited. It is explained as the result of the downward movement of clay particles accumulating in the presence of iron compounds as layers on the surfaces of the underlying material. The true hardpan, averaging about 6 inches in thickness, well defined on its upper surface, can be seen to lose its clay structure gradually on its lower surface. It then becomes more gravelly and so grades rather indefinitely into the ever-present masses of gravel, coarse sand, and silt. These latter materials occur either as mixtures of varying proportions or in roughly assorted beds, all sufficiently cemented to be practically impervious to plant roots even when the overlying hardpan is shattered. It will be noted that the total depth available to plant roots, consisting of the loam with gravel and the small layer of heavy subsoil, is seldom more than 24 inches.

This type is comparatively extensive in the west-central portion of the area and is practically confined to the west side of the valley. At the time when the valley trough had a higher general elevation than at present the material of which this type is composed extended as a vast plain over the section of the Red Bluff area west of the Sacramento River. Present remnants of this old plain are today in evidence in the sections west of the Red Bluff area and south of it in the Colusa area. Partial erosion of this ancient material, with deposition of transported particles to form soil types of a lower level, has left portions now occurring as ridges or elevated rolling plains. These are separated by the minor drainage ways of the valley slopes and mapped as Redding loam.

Its general surface, while rolling and marked by drainage depressions, has detailed features of topography making it, during the rainy season, a poorly-drained soil. Numerous hummocks or "hog wallows" confine much surface water or permit it to escape slowly by meandering courses, little water escaping through the subsurface layers. The type is usually bounded by terrace lines or rather abrupt slopes. Along the courses of present streams these small bluffs are evidence of active erosion. A change in the stream course which allows the bluff to weather into a slope accounts for most of the sharp lines separating this type from the Tehama, Elder, and

Maywood series of soils. It is only in those bodies nearer the alluvial plain of the Sacramento that this type has indistinct boundaries. It is there partially covered by later deposits rather than eroded.

The Redding loam is one of the types derived from what remains of the Red Bluff formation. The coarse material in this type corresponds closely to that found in the Redding gravelly sandy loam, and in both types it is probable that weathering and simple erosion, accompanied by the formation of the hardpans, constitutes the total change in the original material. No evidence appears of reworking or mixture with foreign products. It is treeless and presents a forbidding appearance, affording a scant pasturage for sheep. The type is unsuited for agricultural use, the few small areas of grain it supports being of little importance in extent and yields. In the history of grain growing in Tehama County this type was once utilized to the extent of a few crops, but it decreased in yields and was later practically abandoned.

The possibilities of utilizing this type are important considerations affecting the success of any irrigation project designed to include it. Its area is extensive, and while somewhat elevated a large acreage will probably be irrigable under any general irrigation system. It is, of course, subject to no development without irrigation. Difficulty will be had in preparing some of it for irrigation, leveling being necessary. In most cases furrow irrigation will be the most feasible method of applying the water. It has a limited range in crop adaptation, its shallow depths prohibiting the growth of alfalfa, prunes, apricots, and all deeper rooted crops. It is entirely possible, however, that careful culture of berries, some varieties of grapes, figs, olives, and perhaps peaches, will yield returns justifying a water tax. The use of fertilizers will be necessary and the content of organic matter must be increased. To justify the promotion of irrigation development successfully this type should not be made to bear too great a value. The present nominal price of $12 to $18 an acre, in addition to irrigation assessment, would appear to be sufficient. All attempts to develop it without irrigation water must fail. It is one of the poorest soils of any great extent in the area.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Redding loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24152	Soil	3.5	7.3	5.1	12.4	20.2	42.1	9.2
24153	Subsoil	4.2	4.2	2.9	6.6	17.8	22.5	42.1

REDDING GRAVELLY SANDY LOAM.

The Redding gravelly sandy loam has a considerable range of topographic features, giving the soil a variable agricultural value. Typically it consists of a light-red to a red sticky sandy loam of rather uniform texture but uncertain depth, carrying medium to large quantities of gravel. This coarse gravelly material was all originally of well-defined waterworn character, but the processes of weathering have at this time reduced quantities of it to a subangular state. These fragments occurring with cobbles of rounded surfaces, coarse sand, and quartz pebbles give the surface material a rather more tillable structure than it would otherwise possess. This gravelly material often accumulates in surface depressions or on eroded slopes, and at all times a slight erosion of soil material renders the immediate surface more gravelly than the underlying layers. The fragments seldom attain a size sufficient to interfere with cultivation.

At a depth which varies from 12 to 24 inches the surface soil grades sharply into an exceedingly tenacious red clay loam or heavy loam that is practically free from gravel. It is always compact and has a tendency to crack into rough cubes upon exposure. It sometimes carries small quantities of coarse sand, but even under this condition loses little of its compact character. This subsoil, of great water-holding capacity, seldom extends to a depth of more than 4 feet, being usually underlain at variable depths by a true ferruginous hardpan of cemented clay particles. The hardpan layer is from 1 to 6 inches thick, impervious to water, and impenetrable to plant roots, and rests upon great masses of indurated gravel, silt, and sands. These occur in partially assorted layers extending to great depths and of little value for root development, even though rendered penetrable by blasting. In those cases where the hardpan layer is absent, the subsoil grades into the massive bodies of semicemented waterworn material and the type is perhaps a little better agriculturally by reason of the slight disintegration of the mass at its point of contact with the soil.

This type is confined to several bodies in the northern part of the area. These occur as the southern extremity of the low rolling hills bordering the Iron Canyon section of the Sacramento River and giving way near Red Bluff to the more level valley plains. The material of which this type consists is a Pleistocene alluvial product, deposited to great depths over a considerable section, the present remnants of which lie mainly north of the Red Bluff area.

The surface of this type is gently to sharply rolling and north of Red Bluff much dissected, with excessive drainage and a general topography unfavorable to agriculture. A natural growth of upland oaks, ceanothus, and manzanita cover these latter sections. Those

bodies of small extent occurring south of Red Bluff are partially cleared and developed. Grain, giving nominal yields, is the principal product. The type is as well adapted to dry farming methods as any other of the distinctly upland types, but insufficient and poorly distributed rainfall hinders its development. Irrigation will render a variety of crops profitable. Berries and peaches will predominate, as on this type in the Happy Valley section of the Redding area. It will not be found so well adapted to alfalfa. When irrigated it will be farmed where the topography permits. Exception is made of those limited shallow areas where the underlying impervious material too closely approaches the surface. It is a much better soil than the Redding loam, the latter type lacking the depth of soil and subsoil and at the same time being more poorly drained.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Redding gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24157	Soil	4.1	11.2	8.0	14.4	17.7	30.1	13.8
24158	Subsoil	5.3	8.0	5.1	9.2	24.1	18.9	29.2

CORNING LOAM.

The Corning loam, as typically developed, consists of a reddish loam of slightly sticky character, extending to a depth varying from 16 to 30 inches. It is slightly gravelly at times, the coarse sand and gravelly material corresponding to that found in the gravelly loam of the same series. A slightly compact structure prevails and a mild tendency to clod and puddle is noted. A good condition of tilth can be secured, however, with careful handling when proper moisture content exists. At an average depth of about 24 inches the soil is underlain by a heavy clay loam or clay, always very compact, and showing adobe characters upon exposure. Its dense structure is relieved at times by the presence of small quantities of sand, but not sufficient to make it friable. It may extend to a depth of 6 feet. Over the greater part of the type, however, this refractory subsoil grades sharply at varying depths into a rather compactly cemented mass of clay, sand, and small gravel. This material seems to correspond quite closely with those masses underlying the soils of the Redding series below the hardpan. The Corning loam does not have a true hardpan, but plant roots are practically limited in all cases to the surface loam and heavy subsoil, as the partially cemented

masses above mentioned are impenetrable. A sandy phase, which differs somewhat from the typical soil material, also occurs.

The Corning loam is found in many medium-sized bodies of rather general distribution in the upland plains lying west of the river. The type occupies elevations intermediate between the more elevated Redding series and the slightly lower Tehama and Maywood series. The boundaries of its bodies are rather indistinct at times, gradation zones occurring between it and the other series. Its surface is gently rolling to level, with occasional small cuts or washes and a few local depressions. A slight tendency to form hog-wallows sometimes exists. The ridges, hills, and steep slopes so general in the Corning gravelly loam do not appear in this type. The elevation and slope provide ample surface drainage, except in small, depressed areas. Subsoil conditions frequently make percolation slow, but in general the type may be called well drained. It is naturally barren, an occasional scattered growth of upland oak being its only tree growth.

The Corning loam is derived from the Red Bluff formation. In some instances it no doubt occurs as anciently redeposited portions of that old Pleistocene alluvium. At other times its bodies are remnants of the original formation, the result of an irregular erosion and reworking. It is an upland type and subject to erosion.

The type is not extensively cultivated. A few small areas are dry farmed to grain, but the yields are light. It is rather poorly adapted to dry farming and attempts to produce fruit without irrigation have met with practical failure. It does not possess a subsoil of good water-holding power and must await irrigation for development in all agricultural lines except grain farming. At one time the Corning loam was much more extensively farmed to grain than at this time, but is is doubtful whether its present cultivated area will be increased along any line until water is supplied. Underground water for irrigation is not available, except possibly at points where the bodies of lower elevation approach the river. Even here the great expense of securing water may be prohibitive. The type could be irrigated under an extensive gravity system. With water it will be found adapted to peaches, almonds, berries, figs, grapes, and a variety of crops which do not require a deep, friable soil and subsoil. Alfalfa, prunes, and some of the truck crops will not be found as suitable crops as those mentioned above. The type, if intelligently handled and devoted to the proper crops, will warrant a moderate land valuation and the cost of irrigation.

Corning loam, sandy phase.—The sandy phase of the Corning loam consists of a reddish-gray heavy sandy loam or light loam of rather variable texture. It usually carries small quantities of waterworn gravel, and over small areas coarse sand gives it a more friable

structure than the average. At about 36 inches the soil grades into beds of reworked gravelly material or rests directly upon cemented beds of sandy clay and waterworn gravel similar to those underlying the typical Corning loam, but of a more friable nature. It is extremely variable in its subsoil. The surface soil is usually similar to the soils of the Tehama series, and where erosion or deposition of later stream-borne material has completely changed the surface the type throughout the 6-foot section approaches the soils of the Tehama series, but the subsoil in general is generally of Corning material.

The sandy phase, Corning loam, usually carries a scattered growth of upland oaks and a sparse growth of grass. It is not farmed. Portions of it once produced grain in small quantities, but this crop has been abandoned. It is not adapted to dry farming methods, and some attempts to grow fruit upon it without irrigation have been failures. Water for irrigation is not to be secured by pumping. When the type is irrigated it will be found to possess much the same possibilities as the typical Corning loam. The shallow-rooted fruit crops and berries will prevail to the exclusion of alfalfa, prunes, and apricots, if best results are to be secured. The greater part of it will bear the expense of irrigation and will warrant a moderate valuation.

CORNING GRAVELLY LOAM.

The Corning gravelly loam consists of a light-red or yellowish-red loam of medium texture, often carrying quantities of coarse sand and varying proportions of small angular or waterworn gravel. This coarse material is similar to that carried by the Redding loam. The type is boggy when wet and quite compactly structured when dry, though easily tilled with proper moisture conditions. At from 12 to 20 inches the surface soil is underlain by a deep-red compact, heavy clay or clay loam, practically free from gravel. This subsoil becomes very hard and much cracked when exposed. It is in turn underlain at a depth from 24 to 48 inches by very compact semicemented layers of fine waterworn gravel, clay, or beds of yellow smooth-textured silt.

While the above description represents the typical soil column there are considerable departures from it in different parts of the area. Occasionally the gravelly loam with its heavy subsoil rests upon a well-defined hardpan layer, making the type quite similar to the Redding loam. Again the clay subsoil itself occurs in a partially cemented state, being only slowly penetrated by water. Normally the type does not have a distinct hardpan layer, but subsoil conditions are unfavorable. The partially cemented gravel, silt, or clay usually found at from 2 to 4 feet below the surface is impenetrable to plant roots, and blasting would yield small relief. An average depth of

perhaps 30 inches is available for plant roots, except on slopes or in small areas where a slight wash has accumulated a deeper covering.

The type occurs in the southwestern part of the area in several extensive bodies. Some of the largest occur as the points of several ridges jutting into the area from the west. There are also large bodies east of Corning and Kirkwood, rising in elevation above all the surrounding soils. The surface is usually sharply rolling, eroded by small streams, and marked by a hog-wallow surface. Because of its elevated position it presents marked contrasts to the flatter types of the surrounding series. It is usually bounded by rather abrupt slopes or terraces, and occasional bluffs occur along stream ways.

The Corning gravelly loam has a general surface favoring good drainage, but the many small depressions collect much water which does not readily escape through the dense subsurface layers. A little leveling will, however, make the soil fairly well drained, except during periods of greatest rainfall. The areas are practically devoid of trees and brush.

This type is derived from material constituting the Red Bluff formation. Its nearest counterpart in the soils having a similar origins is the Redding loam. It lacks the clay-iron hardpan of the latter soil and possesses a greater depth and a slightly higher agricultural value.

The Corning gravelly loam is at this time utilized mainly for grazing. It is not capable of development without irrigation. A general knowledge of climatic conditions, with attention to the general character of this type, should convince anyone of the futility of fruit culture without water. Numerous abandoned orchards bear evidence of a hopeless endeavor. A little irrigation by pumping is practiced near Corning, but the type can be very meagerly developed in this manner, because of the scarcity of underground water. It is not at all probable that the underground water of this and adjoining types is sufficient to furnish much irrigation on the Corning gravelly loam. Its future extensive development depends on water from other sources. Such elevated portions as can not be covered by gravity systems can perhaps be brought under water by pumping from canals. It may at some time be watered in part by pumping from the Sacramento River, but the expense seems prohibitive at present.

With irrigation a limited range of crops is possible. A citrus-fruit industry is more likely to be developed upon this type than any other of the area because of air drainage features. Such trials as have been made show fruit of good quality. The climatic conditions are rather adverse, however, for citrus fruits, and the yields are low. Peaches, almonds, grapes, olives, and figs will yield well with water and show a profit if the cost of supplying water does not prove excessive. It

will always be expensive to supply irrigation water for this type and this will no doubt be one of the last soils of the area to be completely developed.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Corning gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24107, 24110.....	Soil.....	6.8	13.0	7.9	10.1	8.8	41.4	11.9
24108, 24111.....	Subsoil.....	5.6	7.4	4.4	6.4	5.4	33.3	37.2

TEHAMA GRAVELLY LOAM.

The Tehama gravelly loam is a loam of medium texture, carries varying quantities of waterworn gravel, coarse sand, and angular rock fragments, and extends to a depth of from 18 to 72 inches. It varies in color from a yellowish brown to a reddish gray and is always very compact and hard upon drying, though easily tilled under proper moisture conditions. The coarse material with which it is mingled corresponds to the finer and medium-sized fragments of gravel, often principally quartz, so prevalent in the Corning gravelly loam, and the Redding gravelly sandy loam with which types the Tehama soil is associated in origin and in position. In those instances where the type is less than 6 feet deep, it is underlain by a compact clay loam or clay similar to the subsoil of the Tehama silt loam.

It occurs as numerous small bodies of elongated outline bordering present intermittent streams or as terraces or benches along former stream courses somewhat above existing drainage ways. In the latter position the bodies are sometimes slightly uneven from gentle erosion.

In elevation, age, and method of formation this type compares with the Tehama silt loam, except that some of the bodies of Tehama gravelly loam occur along present minor drainage ways and derive the soil material as direct wash from the higher lying types of the Corning and Redding series. Along such streams heading in and having their short courses through the two latter series, the Tehama gravelly loam occurs as level strips and gentle slopes of poorly defined outline. It has the typical sparse grass vegetation of the series and is likewise treeless. It is well drained.

A few small bodies are farmed to grain, which practically constitutes the agricultural use to which the soil is given. It is capable of intensive development with irrigation, and while a great deal of it lies surrounded by types of poorer soil there are bodies of sufficient

size well located to make it a soil of great possible value. The surface lends itself readily to irrigation methods and its naturally well-drained character will make it, in all but its most gravelly phases, an important factor in the success of any irrigation enterprise. Peaches, berries, almonds, apricots, and other crops, including melons and alfalfa, will thrive on this soil, which needs only a slightly greater application of water than the Tehama silt loam. Intensive, small farm industries are not possible without irrigation.

The following table gives the average results of mechanical analyses of the soil and a single analysis of the subsoil of this type:

Mechanical analyses of Tehama gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24174, 24176.....	Soil.....	5.2	5.0	3.3	8.9	26.6	38.3	12.5
24175.....	Subsoil.....	1.5	2.1	1.8	6.7	28.0	32.1	27.3

TEHAMA SILT LOAM.

The Tehama silt loam is one of the most important types of the area. It is a comparatively uniform type in its principal characteristics. The soil consists of a compact yellowish-brown or reddish-yellow silt loam, with a depth varying from 10 to 20 inches. In limited areas the surface soil is gritty or even gravelly, being at such times influenced by present washes or indistinct long-abandoned drainage ways, slightly elevated by the deposition of material and now shown only by meandering streaks of gravelly soil. The subsoil, also fairly uniform, is a tenacious brown silty clay loam of impervious structure to 6 feet deep. The material cracks upon exposure and has an adobe tendency. When variation occurs in the subsoil it is found to accompany the change in the surface soil occasioned by the slight reworking by water. In these cases the subsoil in small areas may be quite gravelly. Extensive beds of compact silt, sand, and gravel usually underly this type below 6 feet.

In its occurrence the Tehama silt loam uniformly occupies elevations slightly below the Redding and Corning series, being in most cases separated from them by pronounced slopes or terraces of several feet. From the lower lying soils of the Maywood, Elder, and Sacramento series it is again separated by terraces, often pronounced, along the alluvial flood plain of the Sacramento River. Practically confined to the west side of the river and occupying regions of intermediate elevation, the type occurs as almost uniform plains of gentle slope and barren character, except for a very sparse growth of grass and a few trees along small streams and the lower terrace lines. Its

general surface is not level, being marked by minor drainage ways through the main bodies and slightly dissected at terrace lines. The type at the seasons of greatest rainfall suffers from poor drainage. Over almost the entire surface occur small minor depressions without outlet, oftentimes giving the appearance of a hog-wallow topography. With a heavy burden of surface water completely saturating the soil and filling the small depressions, this condition is still further aggravated by a puddling tendency of the soil and the impervious nature of the subsoil. Altogether it is a somewhat difficult soil to handle extensively in grain farming.

In origin this soil type is more recent than the Redding and Corning series, as is evidenced by their relative positions and occurrences, small knolls and ridges of both series sometimes lying within the areas of the Tehama silt loam as remnants of the older series.

An instance of this may be observed south of Redbank Creek between the main line of the Southern Pacific Railroad and the Corning road running south from Red Bluff. In this case an isolated area of Redding loam, representing an undisturbed body of the Red Bluff formation, was entirely surrounded by soils of more recent formation.

The Tehama silt loam is not normally underlain by hardpan, but in a very few instances hardpan and cemented layers common to other nearby types may lie within 6 feet of the surface.

When grain production was at its height this type was nearly all utilized and returned profitable yields despite its puddled and poorly drained conditions before mentioned. The type has suffered decreased yields in common with all the plains and upland types until at this time it is not extensively farmed. A paying crop of grain can be secured about every third or fourth year by summer fallowing, if favorable moisture conditions prevail. In this uncommon case a minimum rainfall is most favorable.

The more extensive utilization of this type depends entirely on irrigation. It is not adapted to fruit, berry, or alfalfa culture under dry-farming methods, and while partial success may be attained on the better areas, little can be done upon those large typical areas, such as that surrounding Rawson. This type, as mapped, can be relied upon to yield good returns under irrigation, and, considering its area, will contribute to the success of any large irrigation enterprise supplying water at even more than average cost. The features which now render the soil hard to handle in grain, namely, poor drainage and baking, will not be found to retard its irrigation developments materially. A slight leveling of the surface and the formation of a few drains to carry off surface water can be accomplished in small tracts and at a slight expense. This would not, however, be justified by its returns as a grain soil.

This is a better soil as regards its present utilization than the other types of the same series. It will be found to surpass them in its capacity for irrigation development and in its adaptation to general farm crops as well as grapes, the stone fruits, and alfalfa. In common with the other plains soils of the west side, extensive irrigation can only be had by a comprehensive gravity system, supplied by storage of the flood waters of the west-side tributaries or by diversion from the main river at some point at a distance from the area. Underground water for pumping is not available in sufficient quantities or at a cost commensurate with the supply, and the elevation of the areas does not appear to allow extensive watering by pumping from the Sacramento River.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Tehama silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24168, 24170.....	Soil.....	0.5	1.2	1.7	8.2	17.7	57.1	13.4
24169, 24171.....	Subsoil.....	.0	.5	.8	6.3	23.1	47.6	21.4

TEHAMA CLAY.

The Tehama clay constitutes the heaviest and most refractory member of the Tehama series. Typically it consists of a compact clay ranging from a light grayish brown to yellowish brown in color and extending to a depth of 36 to 48 inches. When wet this soil is very sticky, exhibiting the tendency of the adobes to adhere to vehicles or implements. Upon drying it soon acquires a hard, impenetrable structure, cracks and checks. It is of poor tilth throughout. In nearly all cases below this mantle of soil will be found a hard, impenetrable layer of varying character, but in all cases defined as a remnant of the underlying material of the Redding or Corning series. In some cases the deposition of the Tehama clay has occurred directly upon the true hardpan of these series, but usually the older series have been sufficiently eroded to bring the less solidly cemented sands and gravels of their underlying strata next to the clay.

This type occurs in several elongated and slightly depressed bodies, usually where the Tehama silt loam joins the Redding or Corning series. It sometimes occupies small areas between remnants of Redding loam bodies, is always poorly drained during the rainy season, irregularly defined, and of small importance. The surface is treeless and gently sloping to flat, except for an occasional meandering depression, usually subject to the accumulation of drainage water

from higher lying soils. The type owes its origin to the finer material deposited in this manner, and in some cases the process still slowly continues.

At one time the Tehama clay contributed to the grain production of the area, but it has fallen into disuse for reasons common to the other types surrounding it, and at this time furnishes grazing only. At all times it will remain a soil of secondary agricultural worth, but under irrigation, with careful, intelligent handling, it can be developed into a profitable producer of small fruit and even of alfalfa upon its deeper phases.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Tehama clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24172, 24173.....	Soil.....	2.1	2.0	1.8	4.9	18.5	34.9	35.5

MAYWOOD LOAM.

The Maywood loam is subject to considerable minor variation. Typically it consists of a light-grayish or yellowish-gray loam of a rather smooth silty texture. It is at all times moderately friable and easy to cultivate. There are frequent areas of a somewhat gritty, coarse texture. Other bodies of the opposite tendency occur along the intermittent streams, the texture here approaching a silt loam. This loam, in limited areas, extends to a depth of 6 feet, but in nearly all cases is underlain at from 24 to 30 inches by a yellowish clay loam or silty clay loam. The subsoil, although quite compact, is much more permeable to plant roots and water than the clay loam subsoil of the Tehama silt loam. It has a somewhat flocculated structure and bears evidence of having been reworked by water to varying extents. In power to hold water and in adaptation to dry-farming methods it is a much better subsoil than that underlying the Tehama silt loam. Gravel beds may be encountered at a depth of about 6 feet along sites of ancient stream ways or in the vicinity of present washes. Larger tracts have a subsoil extending to depths of many feet.

The Maywood loam occupies some rather extensive bodies in the southwestern part of the area. The country south and west of Corning for several miles is occupied largely by this type, broken by patches and streaks of related soils.

This type has a very uniform surface, being smooth and conforming to the general regional slope, amounting to something less than

20 feet to the mile. It is not so frequently marked by local mounds or depressions as the Tehama silt loam. Practically the only variation in topography within the main bodies of this type is occasioned by the presence of many minor washes. These are only 3 or 4 feet deep, narrow and winding, with gravelly or sandy beds. During the wet season they carry much water, but rarely overflow. None are perennial in character. Aside from these washes, which are the present drainage ways, there are remnants of older ones of their kind, faintly traceable over the general surface of the soil. Such abandoned waterways have in some cases been responsible for the lighter, slightly gravelly phases which occur in the type. The dividing lines between this soil and the Corning series are quite distinct, occuring at marked differences in elevation. The Corning types usually rise in elevation several feet above the Maywood loam. Gradations always prevail at the points of contact between this type and others of the same and of the Tehama series. The drainage of the type is excellent, being neither excessive nor restricted.

The Maywood loam in origin is very closely associated with the Tehama silt loam. It appears that the latter type has been subjected to irregular erosion and redeposition by many meandering streams now evidenced by nearly filled, abandoned channels. This has given rise to the somewhat reworked variable material classed as the type in question. Such an origin must of course give rise to a soil of somewhat irregular character, depending upon the degree of erosion and recovering.

The Maywood loam is treeless, but a fringe of willow and cottonwood, with some brush, is usually found in the beds of the waterways. A better growth of native grasses is found upon uncultivated portions than upon the Tehama silt loam.

The Maywood loam was all farmed to grain years ago, when grain farming so thoroughly occupied the soils of the area. Decreased yields led to the practical abandonment of the soil for this purpose. Since that time great numbers of small orchards have been planted and an endeavor has been made to make this a dry-farmed fruit soil. Peaches, pears, figs, olives, prunes, and almonds have been planted and tended with varying degrees of success. Many orchards were abandoned soon after planting; others were brought to maturity by indifferent methods, to be then abandoned. Principal among the causes for such discouraging results were the attempts made by nonresident landowners to plant and care for orchards by contract. There are scattering orchards located upon the most favorable portions of the type which have been handled by careful methods and thorough cultivation. They show better results in the type of trees and fruit produced. Some of these orchards have been made profitable. Amid such a mass of varied results a few facts have become apparent. If

the Maywood loam is to produce dry-farmed fruit profitably it can only be by use of the most careful methods upon its best phases. While the type is fairly well adapted to dry-farming methods, the long dry summer severely taxes the capacities of the best adapted soils to produce fruit without irrigation. Certain failure faces every careless or incompetent effort. Figs, almonds, and olives seem to be most resistant to weather conditions upon this type when abandoned. An excellent quality of peaches for both canning and drying is produced upon this soil. Profits must always remain rather meager as long as the type remains unirrigated.

Some water is available for pumping, but can never be secured in sufficient quantities to irrigate any large part of the type. Such water as has been developed in this way gives good results and abundantly proves the high value of the soil under irrigation. It is thoroughly adapted to irrigation, and a very wide range of crops can be grown upon it whenever water is applied. The entire area occupied by it is irrigable and can be broken up in small farms once water is available. Twenty acres is amply sufficient for an average family when irrigated in the best manner. All the crops suited to the climate are possible, and it is sufficiently productive to justify a high water tax.

Mechanical analyses of Maywood loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24122	Soil	1.2	2.4	2.8	13.1	19.3	47.2	13.5
24123	Subsoil	1.3	2.2	3.1	13.0	28.1	29.5	22.8

MAYWOOD FINE SANDY LOAM.

The Maywood fine sandy loam consists of a yellowish-gray fine sandy loam, appearing when under cultivation as a rather light-textured loam. It is very friable in structure and usually carries moderate quantities of waterworn gravel. The type does not puddle or crack and possesses nothing to interfere with a natural good tilth and ease of cultivation. The surface soil grades at from 24 to 30 inches into an indefinite subsoil. This is usually either loam or gravelly loam, but in exceptional cases may be composed of gravel beds or light-textured clay loams. At no place do cemented layers or a true hardpan appear.

This type occurs in the west-central portion of the area, being entirely a west-side type. Its narrow bodies border some of the small stream ways as distinct areas of reworked material or strips of alluvial bottom. The surface is usually level, but marked by the

shallow winding bed of the local waterway or its partially filled older channels. Terraces generally separate the type from the Redding and Corning loams and the Tehama silt loam, but in the case of the latter type gradation zones frequently occur. Its contact with the Maywood silt loam and the Sacramento series is marked by slow transitions. It is at all times excellently drained.

The Maywood fine sandy loam is composed of wash derived from the Redding and Tehama series and transported short distances. Its formation has been slow and irregular, at times the result of a reworking of the Tehama silt loam with additions of fresh material. A few valley oaks sometimes appear on this type, and a rather luxuriant growth of wild oats and native grasses cover it in the rainy season. Most of the type has been farmed to grain for many years and, while yields have decreased, the practice continues. A few dry-farmed orchards are located upon it, but the yields are small.

Rapid development of this type must await irrigation, for which it is admirably suited. Practically its entire area is irrigable and suited for alfalfa, peaches, prunes, apricots, and other fruits, as well as melons and many truck crops. Water alone is needed to transform this type into one of small farms and intensive cultivation. Unfortunately, as with many of the other types, it does not appear to possess subsurface water in quantities sufficient for irrigation. Its development therefore depends upon the installation of comprehensive gravity systems.

The following table gives the average results of mechanical analyses of the soil and of a single analysis of the subsoil of this type:

Mechanical analyses of Maywood fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24127, 24129.....	Soil.....	1.8	2.6	2.7	15.1	37.4	30.4	9.6
24128.....	Subsoil.....	.0	.2	.2	5.2	24.7	49.6	19.8

MAYWOOD GRAVELLY SANDY LOAM.

The Maywood gravelly sandy loam consists of a grayish-brown sandy loam of varying character, carrying moderate to excessive quantities of waterworn gravel and coarse sand. It is sometimes rather leachy and porous in character and usually 6 feet deep. The type may be underlain at uncertain depths below 18 inches by gravelly beds of coarse, incoherent structure or by a clay loam closely resembling that of the Maywood loam. This soil is easy to cultivate at all times but occasionally puddles slightly during the rainy periods.

Numerous small bodies of the Maywood gravelly sandy loam occur in the western part of the area, usually bordering the smaller intermittent stream ways and not much elevated above them. The surface is usually level, the only variation being the small stream channels of the locality. The boundaries between this type and the Tehama gravelly loam and other types are often indistinct. It is at all times well drained. No tree growth occurs except in the stream channels, where an occasional cottonwood or willow is found.

The Maywood gravelly sandy loam is an alluvial soil formed from materials derived largely from the Tehama and Redding series. It occurs in the zone of present stream ways, and is quite similar to the Tehama gravelly loam in some of its phases.

Some grain is grown upon the type, and with good care a few dry-farmed orchards of peaches have been brought to bearing. It requires irrigation, however, to insure extensive development. Small quantities of underground water for irrigation can be secured by pumping, but the supply is insufficient. With a gravity system this type will be found admirably suited to irrigation. Practically all of the type is irrigable. It is well adapted to olives, peaches, alfalfa, and a great variety of crops.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analysis of Maywood gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24134, 24135.....	Soil.....	12.9	11.8	6.2	15.9	12.7	31.6	8.6

MAYWOOD SILT LOAM.

The Maywood silt loam consists of a yellowish or yellowish-gray, smooth textured soil, usually quite compact and sticky when wet, yet friable when properly handled. It is very uniform in texture, with but little or no coarser material, such as gravel. At from 30 to 36 inches the silt loam grades into a very compact silty clay loam or silty loam of great water-holding capacity. This in turn may be underlain at about 6 feet by gravel beds or may extend with little variation to great depths.

This type is confined to several medium-sized bodies along the minor west side streams, or as bodies deposited by these streams where they leave their small valleys and emerge into the alluvial plain of the Sacramento. The surface is level and very uniform. Drainage is adequate over most of the type.

The Maywood silt loam is alluvial in origin. The small streams along which it lies have built this soil from material largely derived from the Tehama silt loam and the soils of the Redding series. The outer boundaries are indistinct at points where the type merges into the floor of the Sacramento Valley.

The valley oak grows upon some portions of this type, and this with a few willows forms the tree growth. A better than average growth of grass also occurs, uncultivated areas affording good pasturage.

There are several good orchards on the Maywood silt loam, grown without irrigation, and producing fair returns. There are also several fields of dry-farmed alfalfa producing profitable crops. It is one of the best soils of the area for dry farming and some development can be hoped for upon this type without irrigation, if very thorough cultivation is resorted to in order to conserve the moisture. The whole type is irrigable and well adapted to a wide range of irrigated crops. All the fruits of this section, as well as alfalfa, will yield well and justify a moderately heavy tax for irrigation purposes.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Maywood silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24130, 24132.....	Soil.....	1.6	2.2	1.9	9.5	11.3	57.3	15.9
24131, 24133.....	Subsoil.....	1.3	2.1	1.9	6.4	19.9	48.6	19.4

MAYWOOD SILTY CLAY LOAM.

The soil of the Maywood silty clay loam consists of a very smooth textured gray silty clay loam, very compact, which cracks upon drying, being rather refractory under such conditions. This material extends to a depth of 6 feet, with the single variation that it is occasionally found with a lighter colored subsoil. It is free from coarse sand and gravel. The type is but fairly easy to cultivate, its heavy character and puddling tendency preventing the best of tilth.

Only two or three small bodies of this type were encountered, all on the west side of the river, the largest being near Corning. Its small extent makes it an unimportant type. The surface is usually flat and surface water escapes slowly.

The Maywood silty clay loam is a redeposited product derived from the Tehama soils in much the same manner as the Tehama clay

was formed from other types. Intermittent streams have accumulated this type by gradual wash, and it grades rather imperceptibly into some of the other types of the same elevation.

About 50 per cent of this inextensive soil is devoted to pears, figs, peaches, and alfalfa, the remainder being grazing land. A little irrigation is practiced by pumping, and results give evidence of a natural fertility and adaptation to irrigated crops of the region. With more extensive watering its whole area will be found capable of intensive development. Alfalfa and practically all the fruits of the area are possible. Pears may be found very well adapted to this soil. It can not be made to produce maximum yields without irrigation and the profits derived from it at present are meager. Only small quantities of water are available for pumping, and its development will depend upon irrigation with water drawn from distant sources.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Maywood silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24136	Soil	0.4	1.0	1.4	6.8	8.5	58.5	22.9

KIRKWOOD SILTY CLAY ADOBE.

The Kirkwood silty clay adobe consists of a dark-gray to almost black silty clay or heavy silty clay loam of smooth, very sticky texture. It at all times possesses an adobe structure, cracking into huge blocks, which are subsequently checked and subdivided into small cubes or angular fragments. The type is puddled and miry when wet and exceedingly hard and compact when dry, rendering it a soil of poor tilth and refractory character. It is usually 6 feet deep. The subsoil is occasionally a lighter textured, slightly more friable clay loam, but not of sufficient thickness to modify the soil. A small content of waterworn gravel is occasionally found. In some places the cemented clay, sand, and fine gravel of the contiguous Corning gravelly loam underlies the type at depths below 54 inches.

This type occupies several relatively small bodies partially surrounded by or closely associated with the Corning gravelly loam. Its surface is level to gently sloping, and the areas are quite distinctly separated from the Corning gravelly loam by terraces or steep banks. The surface drainage is rather good, despite the fact that the type often receives run-off from the higher soils. A water-logged

condition sometimes prevails for short periods, owing to the difficulty with which water percolates through the soil.

The Kirkwood silty clay adobe is quite different in texture and structure from the numerous types derived from the Red Bluff formation. It is probable, however, that it is derived from the same or kindred materials, its elevation and location bearing out such a conclusion. It is treeless, but supports a heavy growth of wild oats and other grasses.

The type is partly devoted to grain farming, good yields being secured. Fruit culture is hardly possible without irrigation. All of this inextensive type is capable of development where irrigation water is provided. Underground water is not available, and it must be irrigated by the same methods as the surrounding types. It is believed that pears, alfalfa, and a variety of fruit crops will be well adapted to this type. Its poor tilth will be much improved under cultivation.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Kirkwood silty clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24113, 24114.....	Soil.....	1.1	1.7	1.6	4.0	6.0	52.1	33.4

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 24113, 5.13 per cent.

TUSCAN STONY SANDY LOAM.

The surface soil of the Tuscan stony sandy loam consists of from 3 to 12 inches of reddish or reddish-brown sandy loam, slightly sticky and rather compact. Everywhere over the surface are quantities of rounded bowlders, occurring as an irregular, scattered covering or as numerous meandering strips, occupying the bottoms of shallow depressions. These loose stones, all of volcanic origin, range in size from 3 to 14 inches in diameter. In their disintegration they fill the soil material with quantities of small-sized subangular fragments. This shallow mantle of stony loam, usually of a sandy nature, represents the total depth available for agriculture. It is immediately underlain by masses of cemented waterworn gravel, sometimes roughly assorted and interstratified with beds of fine-textured gray material, some of them being tufaceous, but most of them being gray sand derived from volcanic rocks of various kinds. Numerous exposures bear out the great depth and uniformity of this material. The soil is often eroded over considerable areas, exposing these indurated beds with but a thin irregular covering.

The Tuscan stony sandy loam covers a considerable extent in the eastern part of the area and is locally known as "lava flows." The plains which it occupies usually border the Sacramento and Vina series, distinct bluffs or terraces intervening. Abrupt ascents again separate it from the Rough stony land. The surface of the region occupied by this type once occurred as an unbroken plain but now is somewhat diversified by stream ways with a general slope toward the river trough of about 50 or 60 feet to the mile. It is entirely treeless, except along these small canyons, and in fact supports nothing but a scant growth of grass suitable only for sheep.

It consists in part of residual material and, in places, of reworked stream-deposited material. The surface soil is no doubt largely a secondary residual material—the disintegrated product of the great quantities of bowlders and finer material previously mentioned.

This soil is a nonagricultural type. The very shallow depths available for plant roots, coupled with the unfavorable subsoil condition, makes it the poorest type of the area. It is hard to foresee the time when, even with irrigation, its present condition will be materially changed.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Tuscan stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24177, 24178.....	Soil.....	7.4	14.7	7.9	11.7	16.9	28.9	12.3

TUSCAN STONY LOAM.

The Tuscan stony loam bears strong resemblances to the stony sandy loam of the same series. Typically it consists of from 18 to 30 inches of reddish or reddish-brown loam carrying fewer rock fragments in the soil body and less burdened with the stony surface accumulation than the Tuscan stony sandy loam. It is always underlain at a shallow depth, rarely over 30 inches, by the impenetrable mass of cemented volcanic material previously described. As is the case in the stony sandy loam, this underlying material is sometimes exposed at the surface. The type is subject to little variation except along lines of contact with the Vina series where gradations sometimes occur.

The type occupies several bodies of medium extent in that section of the area east of the Sacramento River. Its general surface is level to rolling and is marked by meandering drainage depressions with indistinct banks. It is at all times treeless and barren in appearance.

In origin this type is almost identical with the Tuscan stony sandy loam. It varies from the latter type in that it usually occupies slightly lower general elevations and has thus received some transported material to increase its depth.

Attempts have been made to grow grain upon this type, but with small success, it being soon abandoned to use as sheep range. At some distant date the deeper parts of this type may be utilized, with irrigation, for shallow-rooted crops. The low state of development at this time, even of better types than this, places its relative worth very low. It will never be adapted to alfalfa or to any of the deeper rooted crops.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Tuscan stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24179, 24180.....	Soil.....	4.0	6.0	4.9	11.8	20.0	30.1	23.1

ELDER GRAVELLY FINE SANDY LOAM.

The Elder gravelly fine sandy loam is much stratified alluvial material of coarse texture and rather recent deposition. It is subject to much variation. Typically it consists of a grayish, rather light-textured fine sandy loam carrying waterworn gravel of various sizes, often in excessive quantities. This material may extend to a depth of 72 inches or be underlain at any depth below 18 inches by stratified bodies of sand, silt, or gravel beds in irregular sequences.

The area of this type is small, being confined to the alluvial bottoms of the principal west-side streams, bordering and but slightly elevated above their present channels.

It is of recent origin, being the material carried and rolled long distances by flood waters and in most cases still subject to overflow and modification by erosion and addition of fresh material. The surface is pitted and strewn with gravel, but generally level, except for intermittent stream ways and abandoned gullies traversing the surface. It usually borders the streams with steep banks, its incoherent structure permitting a sudden change in the channel course by erosion. It naturally supports a vigorous growth of underbrush and frequently a dense tree growth, most bodies being yet uncleared.

It is of relatively small agricultural importance. Owing to its limited extent and porous, leachy character, large quantities of irrigation water are necessary if this soil is to be made productive. At

present no use is made of it except as pasture. Irrigation water can be developed for it by pumping from the stream bed along which it lies. It would be better, however, to use this water in the development of the better types of the same series which possess equal advantages of proximity to pumping sites.

At some distant date when water for irrigation becomes sufficiently abundant to justify a copious application to this soil it may be expected to return fair yields of alfalfa and various fruits, except on the sandy or gravelly unproductive spots. As a whole it does not justify an average tax for water rights, but fortunately its area is limited.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Elder gravelly fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24121	Soil	3.0	7.6	9.6	38.6	11.8	23.4	5.9

ELDER SILT LOAM.

The Elder silt loam consists of a smooth-textured very friable silt loam, ranging in color from grayish to dark gray, and having a depth of 6 feet or more. This material is underlain by coarse alluvium. The few variations from this typical structure are found principally at points of contact with the silty clay loam and gravelly fine sandy loam of the same series, gradual transitions from type to type being the rule. A similar variation occurs at the section where the alluvial materials of Elder and Thomas Creeks approach the flood plains of the Sacramento. In exceptional cases the surface carries a few, rounded cobbles.

The most representative body of this type lies around Richfield, as the rather broad alluvial bottom of Thomas Creek. This body, together with others along the same creek and some of smaller area along Elder Creek, comprises most of the type. They are all confined to the west side. The surface is level and without minor irregularities to decrease the value of the type for farming. It is only slightly marked by shallow remnants of winding waterways, formerly overflow channels or the courses of minor drainage ways. The type is well drained, being sufficiently elevated to escape overflow and possessing no underground features to arrest the percolation of surface water. It is usually separated from the major streams by strips of Elder gravelly fine sandy loam, and where it reaches the

valley edge a low terrace usually marks the beginning of the more elevated series previously described.

In origin this type is wholly alluvial, being the somewhat recent finer material laid down by the two principal west side creeks previously mentioned. It does not appear that wash from the Redding or Tehama series has influenced the type in any marked degree. Great solitary valley oaks dot the surface, remaining members of a heavier growth, and upon uncleared portions they are accompanied by thickets of elder, willow, and coffee berry, contrasting strongly in late summer with the barren appearance just above the terrace. The rocks yielding the particles forming the Elder silt loam lie far beyond the western limits of the Red Bluff area along the stream sources.

It is a first-class agricultural soil, being fully utilized at this time, principally in the production of dry-farmed grain. There are also orchards of prunes and peaches covering limited areas near Richfield, together with some alfalfa irrigated by means of water pumped from the gravel beds of Thomas Creek. The type produces heavy yields per acre of wheat and barley under an extensive cropping system, but can not long continue to be simply a grain soil because of its great possibilities. It is one of the best soils of the area, and with irrigation is capable of a high degree of intensive cultivation. All the fruits, alfalfa, sugar beets, berries, melons, and truck crops will return profitable yields whenever the soil shall be developed by the application of water. This is one of the few types of the west side having access to readily available underground water for irrigation. While the expense of pumping is considerable it is not prohibitive. There are some bodies of the type of older deposition lying slightly above the present alluvial plain, but the surface of most of it lies at an elevation easily reached by a moderate lift with centrifugal pumps. Water sufficient for considerable development could be secured in this way from the gravelly beds of Thomas and Elder Creeks for crops not now possible. The type is not suited to intensive cultivation without irrigation, and while with care trees can be brought to maturity the returns are light. Its proper development requires some comprehensive system of irrigation.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Elder silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24115, 24116.....	Soil.....	0.0	0.2	0.8	16.9	17.1	55.4	9.7

ELDER SILTY CLAY LOAM.

The soil of the Elder silty clay loam consists of a very smooth-textured clay loam, carrying a relatively high quantity of silt. It has about the same color as the Elder silt loam, being a dark gray. The soil is comparatively uniform, rich in organic matter, and easily tilled. It is underlain at 24 to 30 inches by a heavy loam of great water-holding power, a little lighter colored and of more compact structure than the overlying material. In exceptional cases the subsoil carries considerably greater quantities of fine sand, rendering it somewhat more permeable than the typical loam material. Sometimes a small quantity of waterworn gravel is present. At varying depths below 6 feet gravel beds are found.

The Elder silty clay loam occurs in bodies of medium extent along Thomas and Elder Creeks, the largest area being on the south side of the latter stream. The boundaries between this and other types are rather indistinct. In extent, topography, relative elevation, and drainage features it corresponds very closely with the Elder silt loam, the two types being intimately associated soils formed by the same agencies but of different-sized particles.

The Elder silty clay loam is alluvial throughout. Elder and Thomas Creeks contribute to its formation by depositing the finer-textured materials under water conditions slightly different from those surrounding the formation of the silt loam. It is possible that the type is a little older in time of deposition than the rest of the series and has undergone some modification by weathering.

This soil is utilized in the production of grain, heavy yields being the rule. Some small fields of alfalfa are under irrigation. As with the Elder silt loam its great value is not brought out in the production of grain crops, although they must continue in the absence of irrigation. It is perhaps a little less friable and will be slightly less adapted to very intensive cropping than the silt loam, but is one of the first soils of the area in productiveness. Irrigation is all it needs. This could be supplied in a somewhat unsatisfactory, incomplete way by more extensive pumping from the accessible stream beds. A comprehensive gravity system is needed for the fullest development of the type. It will be found well adapted to a wide range of crops.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Elder silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24119	Soil	0.1	0.2	0.4	5.9	17.1	56.6	19.5
24120	Subsoil	.0	.3	.4	9.0	31.8	38.3	19.9

VINA FINE SANDY LOAM.

This type of soil consists of a dark-gray or grayish-brown to almost black fine sandy loam, sometimes micaceous and usually extending to a depth of 6 feet. It has an extremely friable structure and is easy to cultivate. This type is in the main remarkably uniform, although there are small patches where the typical smooth fine sandy texture gives way to a slightly coarser phase or to a soil containing more silt. It is usually free from gravel, except in narrow strips bordering washes, where coarser alluvium may be present. That body lying along Mill Creek often has quantities of andesitic gravel strewn over the surface, orginating from bodies of contiguous Tuscan stony sandy loam. In the few places where the type has a depth of less than 6 feet it is underlain by gravel beds or by the volcanic conglomerate masses of bordering types.

The type is found as an extensive body along Deer Creek, widening as it approaches the town of Vina and reaching the Sacramento River with a frontage of about 1 mile. More limited areas lie along Mill and Antelope Creeks. The boundary lines defining this soil are usually quite distinct in the Mill Creek section, being marked by terrace lines. This is also true along such parts of the Deer Creek body as lie in contact with the Tuscan series. It is only on the valley trough side and in the Antelope Creek sections that gradations into other types are found.

The surface of the Vina fine sandy loam is smooth, but with a considerable slope toward the Sacramento River, averaging in rate of fall the streams along which it lies, or about 30 or 40 feet to the mile. There are many gentle depressions marking the surface, and irrigation in certain parts has rendered these old channel remnants rather poorly drained. Relief of such places by simply freeing the channels through deepening them slightly would render the type well drained throughout. It is porous and subsoil drainage is naturally good.

The valley oak finds a natural home upon this type and this growth yet remains upon uncultivatel areas. Willow, cottonwood, and grapevines grow plentifully along the stream ways.

In origin this type is entirely alluvial, and it is the most recent product of the east side perennial streams, Antelope, Mill, and Deer Creeks. It has been carried from the upper-stream sources and laid down in its present position without a great deal of intermingling with the materials of the Tuscan or other soil series occurring in the area. The process of formation has been accompanied by an erosion of the old Tuscan tuff material.

The Vina fine sandy loam, because of its depth, friable structure, natural fertility, and irrigation possibilities is in its typical occurrence one of the most valuable soils in the area. Its entire area is capable of irrigation, and considerable development along this line

has taken place. It is too valuable a soil for grain growing, although heavy crops are secured from such parts as are not otherwise utilized. Alfalfa is admirably adapted to produce maximum yields and is receiving much attention. Numerous old peach orchards give evidence, by the superior quality and yield of fruit, that this is a stable industry. The orchards are generally rather poorly cared for and maximum profits are not made. The Stanford Ranch has demonstrated the production of wine grapes to be profitable. The type has as wide a crop range as any other in northern California, and more intensive agriculture upon it is fully warranted. Truck crops melons, and all the stone fruits will be profitable. Under intensive methods such a soil under the local climatic conditions is capable of supporting a family upon an average tract of 20 acres.

Vina fine sandy loam, gravelly phase.—The soil of the gravelly phase of the Vina fine sandy loam is subject to considerable variation in texture, structure, and depth, but consists usually of a brown loam of fine sandy texture and of rather loose character, carrying a large content of gravel from volcanic rocks. At a depth varying from 20 to 36 inches it is underlain by cobbles derived from erosion of the material of the Tuscan series or of the indurated volcanic gravel commonly underlying the soils of the Vina and Tuscan series. The surface is usually more or less strewn with angular volcanic cobbles and bowlders. The surface is sloping and is excessively drained.

The type is largely a reworked product of the Tuscan series, in many instances grading into it. Intermittent stream wash largely forms the material and accounts for its variability. It is treeless and of limited extent.

This limited area of soil, indicated in the soil map by gravel symbol, is typically better in agricultural possibilities than the Tuscan series, but poorer than any other of the Vina series. Parts of one or two fields of grain-farmed land appear upon this phase, but at present it is not used to any appreciable extent for agriculture, grazing being practically its use. Parts of it can be intensively developed with water for irrigation.

The following table gives the average results of mechanical analyses of samples of the soil of the Vina fine sandy loam and of a single analysis of the soil of the gravelly phase:

Mechanical analyses of Vina fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24137, 24138, 24139...	Soil...	0.5	2.6	5.7	27.1	33.8	22.1	7.8
Gravelly phase:								
24141.....	...do...	1.9	3.6	4.6	17.7	24.6	21.6	25.5

VINA LOAM.

The Vina loam consists typically of from 20 to 36 inches of brown or reddish-brown smooth-textured loam. In some places the content of silt is higher and the depth of soil greater (6 feet or more) than in the typical areas. Generally the soil is underlain at a depth of about 24 inches by gravel beds. These are composed of reworked transported material derived from the indurated subsoil of the Tuscan series or the type may rest directly upon these undisturbed conglomerate masses. Small quantities of waterworn volcanic gravel are also usually present in the typical soil, though only in exceptional cases in amounts sufficient to influence the tillage or yields. The type is at all times rather friable and well drained.

The Vina loam occurs in several fan-shaped bodies in the delta of Mill Creek and is practically confined to the region influenced by this stream. The surface is level to gently sloping. Its different bodies are separated by the depressions of actual or abandoned channels of Mill Creek which approach the Sacramento River by diverging courses. Rather abrupt terraces, usually bordering these depressions, form the most pronounced topographic feature of the type.

The region occupied by the Vina loam was at one time a part of an extensive plain, large portions of which are still occupied by the Tuscan series. Mill Creek, a perennial stream, traverses this plain in a small valley until it reaches a point about 2 or 3 miles from the Sacramento River, when its main waterway divides into several small channels, some in present use and others abandoned. The Vina loam occupies the areas lying between these channels. Its surface material is the product carried some distances by the stream and intermingled with soil material of the original plain which has been largely removed by erosion. The subsoil, with its variations from loose to cemented gravel, represents the different degrees of reworking to which the subsurface layers have been subjected.

The original vegetation consisted largely of blue oak, with ceanothus and chaparral. Parts of the areas are yet covered with this growth.

Limited areas were cleared years ago and devoted to grain, but its principal area did not receive serious attention until the recent irrigation development in the region occupied by this and kindred types. It constitutes the body of land locally known as the "Park soils." The value of this type without irrigation is small, grain being perhaps the only crop possible and even this giving low yields. With irrigation and intelligent methods a diversity of crops is possible. The soil, generally speaking, is rather shallow for most irrigated crops, so that its range of adaptation is relatively limited. Alfalfa is not to be recommended, and the same is true of all the deeper rooted tree fruits, except on those portions where quite a depth of

soil or a free gravelly subsoil occur. Berries, melons, peaches, and grapes will thrive and give returns commensurate with a moderate land value. The establishment of citrus fruit industries is impracticable.

Vina loam, deep silty phase.—The deep silty phase of the Vina loam is of brownish or grayish-brown color and usually extends to a depth of 6 feet. It is of friable character and yields readily to tillage.

This phase occurs as two or three somewhat extensive bodies below the large terrace line separating the upland Tuscan series from the alluvial plain of the Sacramento River and at a higher elevation than the Sacramento series. In the Antelope Creek section it borders the various channels of that creek where this stream turns at an angle toward the river. As the river is approached the type gradually gives way to the types of the Sacramento series.

The surface of the areas is level, but well drained, and sufficiently elevated to escape flooding by the Sacramento River overflow. Channels of abandoned waterways mark its surface.

In origin this is an alluvial type, formed from material laid down by the east side streams in their shifting courses after leaving the confined channels which they have cut through the elevated plain. The soil is of great depth, but in nearly all cases the volcanic gravel beds underlie it, probably within 20 or 30 feet.

Valley oak, cottonwood, willow, and sycamore along the water courses constitute the natural tree growth. Wild oats and wild grasses grow luxuriantly.

Practically all of this phase is utilized, the greater part for grain growing, but with some attention to irrigated alfalfa, maximum yields of both crops being secured.

The deep silty phase of the Vina loam is much superior to the more elevated and shallower phases and is one of the very best soils of the area. It possesses a wide range in adaptation to crops and is capable of being brought to a high state of cultivation under irrigation. It is well adapted to all the crops climatically possible and will not fail to give maximum yields of peaches, prunes, grapes, sugar beets, alfalfa, and various truck crops.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Vina loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24143	Soil	1.4	2.8	3.6	12.5	19.1	45.8	14.8

VINA CLAY LOAM.

The soil of the Vina clay loam consists of a light-brown, very smooth textured clay loam with a tendency to puddle and crack slightly over a considerable proportion of its area. This material may extend to a depth of 6 feet, but is typically underlain at depths below 24 inches by a slightly lighter colored clay loam or heavy loam, sometimes carrying small quantities of gritty material. At times a few small waterworn, volcanic gravel occur in the surface soil, but never in quantities sufficient to alter field conditions. Everything considered, both the soil and subsoil are remarkably fine in texture and inclined to compact. These characteristics do not prevent the soil from becoming quite friable with proper tillage. At a minimum depth of about 5 feet, usually much more, is found the volcanic conglomerate underlying the Tuscan series. It can scarcely in any instance seriously affect the agricultural value of the type.

This type is rather an important one, occurring in several extensive bodies on the east side of the Sacramento River. It usually occurs as rather broad tracts just below the marked terrace separating the upland Tuscan series from the alluvial valley of the Sacramento. It lies at a general elevation only slightly above the soils classified with the Sacramento series. Along the contact with the Tuscan series distinct lines of division appear, but in separating it from other types the boundaries were more or less arbitrarily drawn.

The Vina clay loam typically has a level surface marked by shallow depressions and abandoned waterways. The type is subject to intermittent overflow by flood waters of the small streams as they emerge from their small canyons into this plains region. The surface drainage is sluggish.

The type is entirely alluvial in origin, being the finer material laid down in quiet water by the lateral drainage ways along the sides of the great alluvial plain. The material is derived largely from the Tuscan series of soils.

In a natural state the Vina clay loam supports valley oaks of large size. Luxuriant growths of wild oats yield hay upon such portions as are not under cultivation. Grain growing constitutes practically the only use of this type at present and without irrigation the production of this crop alone must continue. Good yields are the rule. It is not believed that much headway toward intensive cropping can be made without irrigation. Beyond doubt the soil is admirably adapted to a variety of crops, making small holdings possible. Such irrigation development as has taken place in the vicinity of Los Molinos indicates that the type is well suited to alfalfa, the stone fruits, and a great variety of general farm crops. It is a good soil and practically its entire area is suited for subdivision into small farms whenever irrigation is provided.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Vina clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24144, 24146	Soil	0.4	1.0	1.4	7.3	22.3	47.9	19.2
24145, 24147	Subsoil	.2	1.2	1.7	8.4	20.4	46.4	21.1

VINA CLAY ADOBE.

The Vina clay adobe is a very dark-gray or black, heavy textured clay of pronounced adobe structure. It is extremely hard and compact when dry and cracks into the typical rough cubes. When wet it is almost impassable because of its sticky character. Altogether it is a refractory, poorly structured soil, although carrying quantities of small volcanic gravel throughout its principal bodies. It has many small drainage ways down its slopes, sometimes defined as water channels, but usually occurring as ill-defined meandering depressions without abrupt banks. These depressions contain great quantities of roughly shaped volcanic bowlders from 3 to 8 inches in diameter and give the surface a netted appearance. This gravelly adobe material usually does not have a depth of more than 20 to 48 inches where it grades sharply into the indurated mass of gravel and volcanic tuff which underlies much of the east side of the valley.

Boundaries of the areas of the Vina clay adobe are rather indistinct and transitions rather than sharp lines characterize its contact with other types. It includes frequent small bodies of Tuscan soils. There are a few minor areas of the type occurring below the terrace and associated with the alluvial plains soils and here a greater depth of soil, absence of the surface accumulations of bowlders, and a flatter surface prevail. This latter phase, which is indicated upon the map by ruling, covers several poorly drained depressions occurring within the Vina clay loam. The main bodies extend irregularly down the slopes within bodies of Tuscan stony sandy loam, being associated with that type in position and elevation, and so properly classed as an upland soil.

Its general surface is that of a sloping plain of good average drainage, except along its lower borders where the fall decreases on contact with lower-lying types. The greatest variation in surface condition is caused by the parallel or winding stone-laden waterways.

In origin the type is probably colluvial and alluvial. It is formed mainly of material brought from beyond the eastern boundary of the survey by intermittent streams.

Except in those limited areas previously mentioned as lying below the upland, the type is treeless. A sparse native grass does little to relieve the general barren and desolate appearance of the areas. On the low-lying bodies valley oaks are found. Here the general conditions of development are more like those of the poorly drained portions of the Vina clay loam.

At present the type is not cultivated except for grain growing upon certain small areas favored with greater depth of soil than usually found. With the Tuscan stony loam of the same region it is used for grazing and can be correctly classed as a grazing soil. It is a poor soil for ordinary crops, owing to its shallow depth, stony surface, and unfavorable structure. If anything is ever made of this type it will come as a result of considerable effort in overcoming these natural physical defects. Irrigation will of course be necessary. Little hope of immediate development can be entertained for the bulk of the type. Even with irrigation no deep-rooted crops will make a vigorous growth, and the same holds with regard to the truck crops, owing to their need of constant cultivation. Perhaps pear and grape culture may prove possible. In any event the soil must be conditioned by careful cultivation and the use of green manures to secure a granulated structure, which it does not now possess.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Vina clay adobe.

Number.	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24148, 24149.....	Soil.....	1.5	2.6	2.2	4.3	9.0	33.3	46.9

SACRAMENTO FINE SAND.

The surface soil of the Sacramento fine sand consists of a fine-textured, brownish-gray, micaceous sand of loose structure. It may extend to a depth of 6 feet, but is usually underlain at varying depths below 12 inches by material similar to that forming the silt loam or fine sandy loam of the same series. It is subject to considerable variation, and owing to its manner of formation is marked by many small patches of related soils.

It occurs in several bodies of small extent, or islands, along the Sacramento River. The type is subject to annual overflow, either entirely or in the numerous cuts and waterways, which give it a much disserted and eroded surface by their constantly shifting courses.

It is alluvial in origin and is the comparatively recent product of flood waters, being the medium-textured alluvium deposited by flood waters. At some points where the floods sweep across low-lying land occupying bends in the Sacramento River, severe erosion has taken place, accompanied by deposition of fine sand as an irregular covering. At earlier times some sections now occupied by this type were not subject to such frequent flooding and so were cleared and utilized for agriculture. Slight changes in the river increased erosion, resulting in the abandonment of the small sections so affected.

Most of this type has never been cleared and supports the thickest jungle to be found in the Sacramento bottoms. Lofty cottonwoods, sycamores, and oaks with interlacing branches are often festooned to their tops with masses of wild grape vines. Beneath the trees occurs a tangled growth of wild rose bushes, weeds, brush, and grapevines, while masses of driftwood render the areas almost impenetrable.

The type is uncultivated and will remain so until the river is effectually controlled. It is overflowed and eroded even by floods of low stage. Protected, the type could be cleared, leveled, brought under irrigation, and devoted to a variety of crops. The expenditures and broad general development of the whole river course which must precede the farming of this type places it in the list of non-agricultural soils for many years.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Sacramento fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24165	Soil	0.0	0.3	2.2	75.6	15.3	3.1	3.0

SACRAMENTO FINE SANDY LOAM.

The Sacramento fine sandy loam of the Red Bluff area typically consists of 6 feet or more of rather smooth-textured, slightly micaceous fine sandy loam, usually light brown in color. In those exceptional cases where the fine sandy loam material is less than 6 feet deep, the subsoil consists of gravel beds, fine sand, or a very silty fine sandy loam, approaching the lighter phases of the Sacramento silt loam. In any case the typical surface soil is rarely less than 48 inches in depth and of rather uniform structure throughout. Negligible quantities of waterworn gravel occur in certain small areas influenced by swift water action. At all times the type is very friable, requiring minimum attention to cultivation to secure good tilth.

This soil occupies elongated bodies bordering the Sacramento River, having a place upon one or both banks of the stream throughout practically its whole course in the area. Its contact with the river is close, there rarely being intervening types other than Riverwash or small bodies of Sacramento fine sand. It is sometimes marked by strips of Riverwash representing portions vigorously reworked and redeposited by flood waters. The type is confined to the area directly influenced by the Sacramento River.

The surface is rather uniform, except for the overflow channels. In general the topography is comparable to that of the Sacramento silt loam, but the areas usually occur at an elevation slightly lower than that of the latter type. Much of the type is subject to periodic overflow.

The Sacramento fine sandy loam is an alluvial soil, the product of direct deposition by the Sacramento River and, with the possible exceptions of the Sacramento fine sand and Riverwash, the most recently formed soil of the area. It is yet in the process of formation and alteration. The source of its material lies far without the area along the Sacramento tributaries.

A native timber growth originally covered this type, oak, willow, sycamore, and cottonwood prevailing. Large areas have been cleared in the course of development of agriculture, but there yet remains upon the lower areas a rank jungle, consisting of the trees already named, underbrush, and grapevines.

This soil is one of the best and most productive of the area and its intensive development in small farms will depend entirely upon the engineering difficulties attending protection from overflow and the supplying of water for irrigation. The range of crops to which the type is adapted is very great. Some of the best peach, apricot, and prune orchards of the area are located upon it, these products being grown usually without irrigation. The soil has good water-holding capacity, but where irrigation is possible it is deemed advisable. It is an excellent alfalfa soil and good returns are had without irrigation in well-established fields.

Maximum yields are obtained where irrigation is practiced, as it is by several individual pumping plants along the Sacramento River. Hops do well without irrigation whenever favorably located upon bodies not too vigorously overflowed, yet having the moisture conditions of the lower levels. Grain farming is as yet the most extensive industry upon this type, and wheat and barley continue to produce profitably year after year without marked decreases in the yields. The humus content of the soil is very satisfactory, and much greater than in case of any of the upland soils. Beans, melons, and various truck crops do well whenever moisture conditions are favorable. Irrigation will not fail to make intensive, diversified agriculture suc-

cessful upon all the more elevated parts. It will be very difficult to relieve flood conditions on islands and areas in the river bends. At present clearing areas of this sort is not advisable, as erosion would damage the surface beyond repair.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Sacramento fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24167	Soil	0.0	0.5	4.1	35.4	28.0	17.9	13.5

SACRAMENTO SILT LOAM.

The Sacramento silt loam consists of a brownish-gray silt loam of smooth texture, and slightly compact structure. It is usually micaceous. Typically it extends to a depth of 6 feet, bands of lighter material only occasionally intervening. The surface is often marked by patches of sand distributed along overflow channels or across relatively low bodies swept by flood waters. The type below 30 to 36 inches often assumes a texture closely approaching a fine sandy loam in appearance, but still carrying large quantities of silt. The soil is retentive of moisture. It is modified slightly in certain sections by the addition of material from other soils, but in general the texture and structure are uniform. Below 6 feet are found materials of varying character but similar origin, and at some depth it is underlain by the coarse alluvium laid down by swift water.

The type occurs as extensive elongated bodies bordering the Sacramento River and forms a large part of the low-lying bottom lands. The areas often lie next the river, there being a sharp drop of from 20 to 30 feet to the water. In other places strips of Riverwash or other types of the Sacramento series intervene, but never types of other series.

A terrace usually bounds the type on the outer edge of the Sacramento bottoms. A very definite boundary occurs in these cases, except where the terrace gives way to permit the entrance of lateral drainage and alluvial strips of foreign origin, which finally lose their identity in the great mass of Sacramento material. There are no great differences in elevation within the bodies of this type, but the surface is usually marked by overflow sloughs or abandoned channels paralleling the river in a general way. Over the greater part of the type these depressions with sloping banks carry water during floods, often in sufficient volume to cover the flatter portions as a sheet or submerge all but the highest parts. It is only in the slightly lower

sections at the great bends that the river sweeps across the areas of this soil with a force sufficient to damage the surface by erosion. The internal drainage of the soil is free, and when protected from floods and irrigated moisture conditions should be satisfactory.

At the time when the first white settlers occupied this section of the valley the areas of this type were rather heavily wooded. The valley oak, with a vigorous undergrowth, predominated in the better drained parts slightly removed from the river. The areas subject to continued flooding supported a tangled growth approaching the tropical jungle in density. Portions of the type now cleared for agricultural use are still dotted with individual valley oaks of great size and marked by strips of brush and woods along the principal overflow channels or lateral stream ways meandering toward the Sacramento. There are large sections, however, which retain the tangled growth of vegetation—chiefly oak, cottonwood, sycamore, willow, and wild grape. These are the parts never cleared, because of flood conditions, or perhaps abandoned even after clearing, on account of changes in the overflow channels. The uncleared area still forms a considerable percentage of the total area of the type. From present indications the cleared area will not soon be extended. Without the existing vegetation much erosion would result, and it is better to allow the land to remain as it is until the river is brought under control.

The type owes its origin entirely to the activities of the Sacramento River, being the finer alluvium deposited in very quiet water by the floods in that stream. The material of which it is composed has been gathered from the varied rocks of the upper Sacramento watershed. The thorough intermingling of particles during transportation gives the type its uniformity in this and the other areas of the Sacramento Valley.

The agricultural development of this type occupied the attention of the pioneer farmers of the area. It was slowly cleared at considerable expense and became one of the important grain soils, yielding heavy crops of wheat and barley. Such uncultivated portions as remain continue to be used as pasture land or are the source of firewood and fence posts. The greater part of the type is still used for dry-farmed grain and without such marked decreases in yields as accompanied the continued cropping of the upland soils. It is one of the best grain soils of the area and profitable yields of these crops can be expected for many years, although the natural adaptation of the type indicates its use for other crops when it is protected from floods. During recent years it has been found profitable to grow alfalfa upon this type without irrigation, three cuttings being usually secured, the yield aggregating about 5 tons to the acre. Near Alfalfa the broad area of this type is largely devoted to dry-farmed alfalfa, but the

fields would last longer and the yields would be increased by irrigation.

The type is excellently adapted to a great variety of fruit and truck crops and supports some profitable orchards of peaches, prunes, apricots, and almonds, in the main without irrigation. Some of the oldest and best-yielding orchards of these stone fruits are found upon this type. It is well suited to sugar beets, and much attention may be devoted to this crop at a future date when conditions for irrigation and marketing the product become more favorable. Hop culture will also prove successful either by selecting the less elevated and moister portions of the type or by supplying irrigation water. The vineyards of wine grapes owned by the Stanford Ranch at Vina cover a portion of this type.

A wide diversity of crops, embracing practically all the industries of northern California, with the exception of the citrus fruits, can be successfully established upon this type, but that intensive development of which the type is worthy must be delayed until it is relieved of flooding during the winter and spring months. Irrigation will be necessary to warrant its use in small tracts. It is a very productive soil, and under the best conditions it should support a family on 20 acres or less. Its natural value will warrant the expense incurred in developing water. All of its surface is capable of irrigation when protected from overflow.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Sacramento silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24160	Soil	0.0	0.2	0.9	9.2	14.5	58.6	16.5

SACRAMENTO SILTY CLAY LOAM.

The soil of the Sacramento silty clay loam consists of a very smooth-textured, dark-drab to brown silty clay loam of compact structure. It is somewhat sticky, though it seldom puddles, and has a rather friable structure for a soil of its character. This soil is normally free from all coarse material and usually extends to a depth of 6 feet. In exceptional cases it is underlain below about 30 inches by a slightly lighter colored and coarser textured loam or silt loam. It is subject to little variation, except along its contact with other types.

The type occupies several bodies of small extent occurring in the flood plains of the Sacramento River. Its surface is level and marked by the shallow depressions of abandoned or present overflow

waterways characteristic of the series. It is usually well drained, but subject to overflow. The areas were originally rather heavily wooded, but are now for the most part cleared. Scattered oaks occur through the fields, and cottonwood, willow, and grapevines form strips of woodland along the drainage ways.

The Sacramento silty clay loam is wholly alluvial and owes its origin to the sediments deposited by the Sacramento River under conditions favoring the segregation of its finest particles.

For many years it has been devoted to grain farming, and still yields profitable returns. Small areas of dry-farmed alfalfa also occur.

The soil is admirably adapted to sugar beets and its entire extent could be devoted to this crop with irrigation. Alfalfa, truck, hops, and various fruits are likewise suitable crops for production with irrigation.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sacramento silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per rent.*	*Per cent.*	*Per cent.*
24161, 24163	Soil	0.0	0.5	0.8	8.1	13.8	50.9	25.6
24162, 24164	Subsoil	.1	.8	1.5	11.1	16.1	53.1	16.8

RIVERWASH.

Riverwash is a nonagricultural type of very coarse texture, largely composed of waterworn gravel, with coarse sand and some finer sediments in varying quantities. It is leachy and incoherent in structure.

Riverwash occupies low-lying flood-swept areas, strips or islands along the Sacramento River, and similar small areas in the beds of lateral streams. The principal body found outside the flood plain of the Sacramento lies in the gravelly bed of Thomas Creek.

Riverwash usually has an uneven surface and is subject to erosion or reworking at frequent intervals. The water table lies near the surface, and upon areas not recently disturbed cottonwood and willow make rapid growth. As a usual thing the type presents a very barren appearance.

This type is of course entirely alluvial in origin, most of its material being rolled into position during floods. Similar materials underlie some of the heavier alluvial types.

ROUGH STONY LAND.

As the lower slopes of the Lassen Peak Range approach the area from the east they give way to an elevated dissected plain of vol-

canic origin, a part of which covers a considerable area in the northeastern part of the Tehama Quadrangle. This plain in turn breaks uniformly by steep descents into the Tuscan series, and a strip about one-half mile in width was included in the survey which constitutes the Rough stony land of the Red Bluff area. Eastward from that arbitrary boundary line, running northwest and southeast, this type extends indefinitely as the variable, broken nonagricultural section of the high plains and foothills.

Rough stony land has a surface too precipitous and rocky for agriculture. Its surface is strewn with great quantities of volcanic bowlders, marked by rock outcrop and cut by the small canyons of drainage ways (see Pl. II, fig. 2). The fine-earth material consists of a reddish loam somewhat like the soil of the Tuscan series, and the boundary between Rough stony land and the Tuscan soils was established along the line at which the rougher slopes gave way to conditions favoring agriculture, so far as topography is concerned.

A scant growth of upland oak, chaparral, and native grasses cover the areas of Rough stony land. Grazing is the only purpose for which it can be used.

SUMMARY.

The Red Bluff area covers about 326 square miles of the northern extremity of the main Sacramento Valley. It consists of slightly elevated treeless plains cut by small alluvial valleys and by the Sacramento bottoms. The upland plains are sparsely settled and little farmed.

Transportation is furnished by two lines of the Southern Pacific Railroad and by river steamers. Markets are found for the green fruits and vegetables in the contiguous territory of northern California and Oregon. The staples enter the world markets.

Red Bluff is the principal town, with a population of 3,530. Corning, Tehama, and Vina are other places of importance.

The climate differs little from that of the remainder of the great Interior Valley. Red Bluff has an annual rainfall of 26.33 inches. The summers are hot and rainless, but not oppressive. Long growing seasons occur, with little damage from frost. Prevailing winds are from the north. The general climate is favorable to the production of a great variety of fruits.

Agriculture was begun in 1852 and the area developed into an important grain-producing section. Decreased yields and lower prices caused a shrinkage in the area so used. The dry-farmed fruit industry has been developed until it occupies much attention. Peaches are the leading fruit. Land holdings are usually extensive, and some ranches of several thousand acres occur. Some failures have followed injudicious colonization.

The soils of the Red Bluff area are separated into 28 types, 2 of which are nonagricultural. The 26 agricultural types are classified into 9 series.

The Redding series, consisting of two types, covers extensive areas. The soils are rather poorly adapted to dry farming. The Redding loam is the most extensive type. These soils are confined to the area west of the Sacramento River.

The Corning series, also of the west-side section, includes two types. The series is poorly adapted to dry farming.

The Tehama series, including three types, is found west of the river. These soils are dry farmed to grain to a limited extent. They possess great possibilities for development under irrigation.

The Kirkwood series is represented by a single type, the silty clay adobe. It gives moderate yields of grain under the dry-farming system. With water it will be found a useful soil for a variety of crops.

The Maywood series, comprising five types, is better adapted to dry farming than the series previously mentioned. They will be very valuable soils whenever irrigation is supplied.

The Elder series comprises three types. These are alluvial soils and are among the most fertile in the area.

The Tuscan soils are practically nonagricultural. Two types occur, occupying great areas on the east side of the valley. The soils are very shallow and underlain by impenetrable beds of cemented gravel and volcanic tuff.

The Vina series, consisting of four types, lies on the east side of the Sacramento. Its soils are brownish in color and for the most part rather friable. The soils are alluvial and prevailingly deep. Some of the types are among the best soils of the area.

The Sacramento series, with four types, occupies the alluvial bottoms of the Sacramento River. The soils are deep and friable and of high agricultural value.

Irrigation is practiced in several localities in the area, principally on the east side of the river. The perennial streams there yield a very valuable flow of water. Some pumping is done along the stream ways and in the vicinity of Corning. The Sacramento bottoms are subject to periodic floods, which can only be remedied by extensive works of storage and control. Other soils of the area are remarkably well drained.

No alkali is found.

Irrigation development must precede intensive farming. This can be fully achieved only by works of a comprehensive scope.

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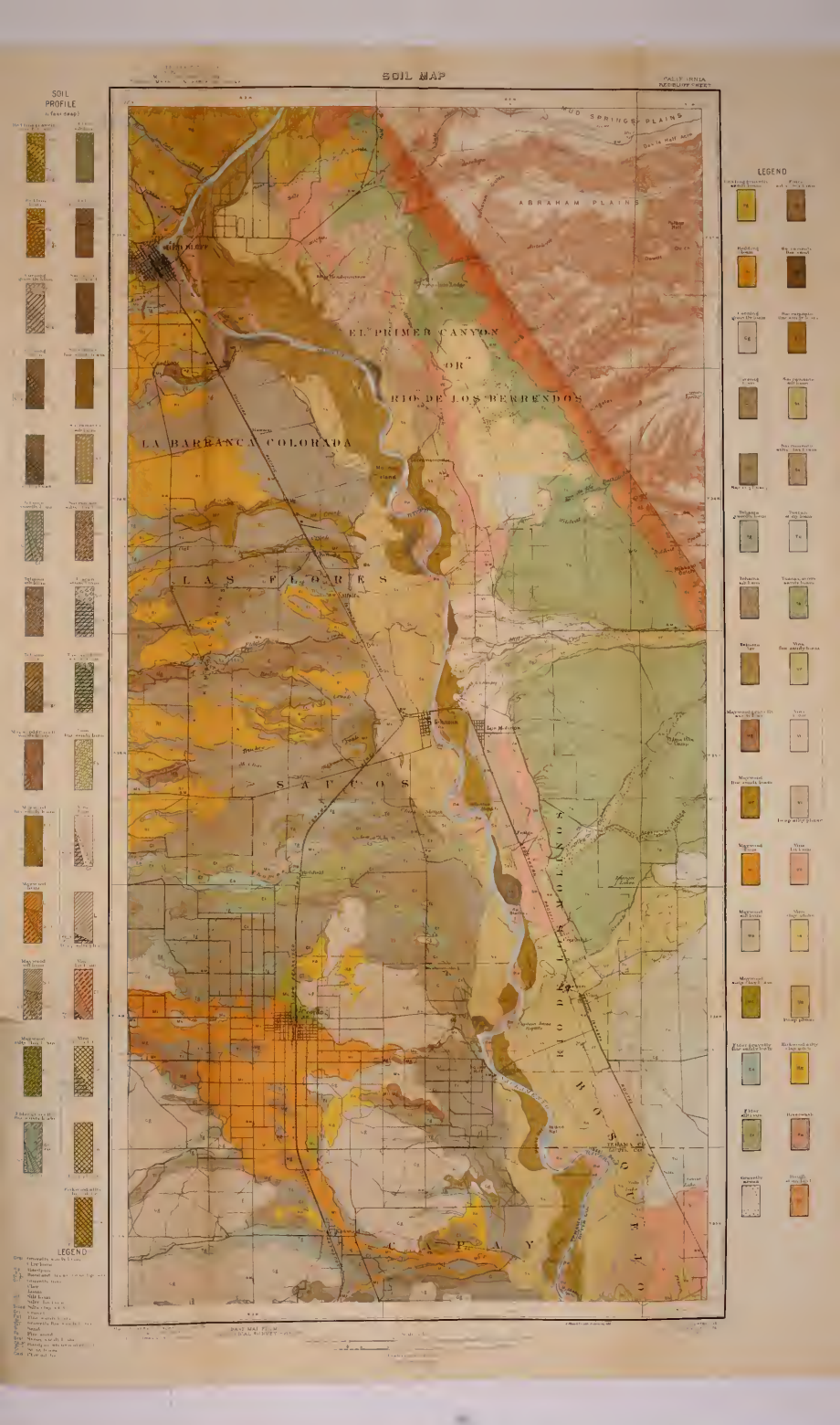
SOIL MAP
CALIFORNIA
MERCED SHEET
SOIL PROFILE
LEGEND
MUD SPRINGS PLAINS
ABRAHAM PLAINS
EL PRIMER CAÑON
OR
RIO DE LOS BERRENDOS
LA BARRANCA COLORADA
LAS FLORES
SAUSOS
CHOWCHILLA RIVER
FRESNO RIVER
CAPAY
LEGEND

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]